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JUL 25 1927

Engineering News-Record

Devoted to Civil Engineering and Contracting. McGraw-Hill Publishing Company, Inc.

July 21, 1927

MAINTENANCE has taken its place in the front rank of highway administration. The general organization and administration of maintenance, as well as special problems, have been recorded from time to time in *Engineering News-Record*. Now the broader issues concerning machinery, materials and methods are of pressing interest. In the series of seven articles, beginning in this issue, leading highway engineers and administrators answer puzzling questions relating to maintenance control (by state or by county under state control); conservation and replacement of equipment; force account work vs. contract work; winter maintenance; and the federal viewpoint on maintenance control. The authors of these articles are: J. T. Donaghey, former state highway engineer, Wisconsin; W. F. Rosenwald, maintenance engineer, Minnesota; G. F. Schlesinger, director of highways and public works, Ohio; W. A. Van Duzer, deputy engineering executive, Pennsylvania; V. R. Burton, engineer, research and statistics, Michigan; and Thomas H. MacDonald, chief, Bureau of Public Roads, Washington, D.C.

"I Want The Same Roof That's On That Old Boiler House"

"THE layout for the new foundry is all right" continued the president of one of America's leading corporations. "When it comes to the roof, I want to put in a word. See that old boiler house over there. The roof has been on for over fifteen years and we've never spent a dollar for maintenance. I want that kind of a roof on our new foundry." "Why that's the type of roof I intend to use on the new foundry" said the architect. "It's Federal Tile."

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGraw-Hill Publishing Co., Inc.
JAMES H. McGRAW, *President*
E. J. MEHREN, *Vice-President*

FRANK C. WIGHT
Editor

Volume 99 NEW YORK, JULY 21, 1927 Number 3

A Neglected Opportunity

A MOVEMENT has been under way for some years to make a comprehensive study of flood records in the United States and analyze them in the light of all data available here as well as elsewhere in the world, to guide us most effectively in forecasting future flood possibilities and thereby assisting our communities and engineers in providing adequate protection against floods. This movement has languished for lack of funds to carry out the compilation and analysis. The American Society of Civil Engineers, which initiated the work, has supported it to some extent, but so far has not been able to finance the work completely. The government has not supported the work, although it is precisely of a kind with the current work that is being conducted by several government bureaus. Congress has not provided funds for the investigation, and the bureaus concerned have apparently not been interested and aggressive enough to request Congress to appropriate the funds. The result is that all flood planning in this country continues to go ahead on the basis of hit-or-miss judgment based on scanty local data, and without the aid of the vastly better basis of prediction that would result from a countrywide study of stream flow and flood records. Last week we had occasion to refer to a cloudburst flood in Germany, as an illustration from a country of long-time records that floods may occur which surpass all records for hundreds of years. If in the face of such a demonstration we continue to build flood protection work on the basis of 25 or 30-year records, or on the basis of forecasts made from such records, the procedure is nothing less than extravagant and foolhardy. Flood study is obviously urgent in a year featured by a record-breaking Mississippi flood and the disquieting further possibility that it suggests. With a parallel demonstration of long-time flood possibilities from another part of the world it is in order to seize upon this long neglected opportunity by financing and organizing a thorough study of American flood possibilities.

Bridge Traffic Possibilities

IN its first twelve months the Delaware River bridge, opened on the first of July of last year, produced a total income of something over $2,100,000, representing a gross revenue of almost 6 per cent on its cost and a net — after deducting operation and maintenance — of about 5 per cent. This result was achieved on very low rates, 25c. for the ordinary vehicle. It surpassed the best advance expectations by more than a third, and makes it certain that an amortization fund will accumulate beginning with the current year, and that the bridge will be paid for in a very short period. The record of the Philadelphia bridge is one of the finest demonstrations yet had of the great potentialities of highway bridge traffic at strategic points. The service of such a structure and therefore its possible toll yield are very great. Bridges of apparently forbidding cost can be justified by these earnings. It is one of the instructive facts of the Philadelphia bridge experience that the traffic of the early years can retire the investment, thus permitting the structure to be integrated with our universal free transportation system.

Missouri Falls Into Line

MISSOURI has fallen into line with nearly all the other states in the Union that have acted on the subject and, through its supreme court, declared city zoning constitutional. This is the more notable because in doing so it has reversed itself. Doubtless this is largely due to the decision of the U. S. Supreme Court in the Euclid, Ohio, case. The decision, which is summarized in our news section, justifies zoning as an exercise of the police power and is flat-footed in saying that no large city could ever get anywhere with zoning if it relied upon eminent domain for the purpose.

Sheetpile Cofferdam Construction

A NOTEWORTHY accomplishment has been made in putting down the piers of the Arlington Memorial bridge in single-wall open cofferdams successfully, with no incident or difficulty. The operation gives an excellent illustration of what modern steel sheetpiling can do when handled with skill. It may be recalled that when this pier work was put out for bidding, an unusually large range of prices was received, covering both open-pier and pneumatic-caisson proposals. The successful bid was on the former type; it was so low that doubt was entertained whether the work could be put through at the figure named unless methods of most rigid simplicity were adopted and proved adequate to cope with the problem of reaching rock through the soft Potomac River bottom. Actually a very simple and straightforward construction plan was used. The results demonstrate that with careful work in setting and sealing sheetpiling, and attention to putting rigid bracing in place, it is possible to deal safely with conditions that in the past would have been considered hazardous. They suggest, moreover, that similar work can be carried to much greater depth, an inference supported by the recent award of the New Jersey pier contract for the great Hudson River bridge on an open-excavation proposal at a figure well below the best pneumatic bid. The range of open construction methods is obviously increasing, and has a fair prospect of increasing still more.

A Notable Series of Articles

MAINTENANCE is the persistent and ever-increasing task of public roads administration. Construction fluctuates. Even in the states most noted for their full and continuous construction programs the curve of new construction has its sharp dips and rises. In the years when the people pause to take breath in the fierce

race to provide money for roads as fast as the traffic calls for them there are valleys of reduced production and in the other years when funds are lavish there are peaks of activity. And it follows of course as the cumulative road output of lean and fat construction years rounds into the full mileage of the planned systems that the curve of construction will exhibit decreasing levels. With maintenance there is no great range of annual fluctuation and as time goes on and road systems approach complete construction the upkeep curve mounts to constantly higher levels. Maintenance is the continuing business of highway improvement. It and traffic management are the future great problems of public roads officials. It calls for no apology therefore that seven issues of *Engineering News-Record*, beginning with this issue, will contain a symposium of opinion on highway maintenance administration theory and practice. These articles have notable authorship. Their subjects are timely and important. They are of direct concern to every engineer whether or not he is engaged in road building. They should be read.

More Scavengers

SAN FRANCISCO enjoys the distinction of being the only large city in the country that depends upon private scavengers for the collection of its garbage. For many years the collection service has been operated virtually as a monopoly, for, although the individual scavengers are many, they are organized into an association and there is a standard schedule of collection rates fixed by city ordinance. An amendment to the city charter was adopted June 4 by a vote of about 37,000 to 33,000, which changes this to a marked degree. The vote was on what is known as an initiative ordinance made necessary by the securing of a requisite number of signatures through the agency of a company that was organized to break the alleged monopoly. Under the new plan another scavenger must be licensed whenever a petition to that effect is submitted by 20 per cent of the patrons on any one of the garbage collection routes into which the city is divided. This may break the monopoly, if there is one, but it seems likely to put San Francisco in a still more anomalous condition than now as regards garbage collection. Since the new order of things is brought about by a charter amendment, it can be changed, if it does not work well, only by another amendment, a situation that voters and city administrators on the Pacific Coast seem to like, but that would hardly be tolerated, as regards such administrative details, in other parts of the country.

A Question of Kindling

IT WAS amply demonstrated long ago, most strongly by an epidemic of bridge fires some years back, that when the wooden floor of a bridge catches fire it keeps on burning, usually with great rapidity, and the fire being difficult of access is almost impossible to put out. It is a question only of kindling the fire. The Danville case, reported in this issue, continues this series of fires. While it does not add force to the teaching just stated, it supplements it with the information that a tar kettle is an excellent means of kindling such a fire. The floor of a bridge, we would conclude, is a good place from which to keep special fire hazards away, and if they cannot be kept away, to guard them very carefully. Every tar kettle, for example, that is hauled onto a bridge ought to be accompanied by a truckload of fire-prevention caution as a trailer.

Long-Time Strength

SOME time ago we remarked that in proportioning structures for what is ordinarily considered static service engineers may soon have to depart from traditional views of working stresses and give more consideration to the facts of endurance tests. Steady advance in the study of fatigue phenomena has since gone on, and each new result seems to tend further in this direction. The latest research results are reported briefly in the current issue, in a condensation of the form in which they were presented before the American Society for Testing Materials a month ago. The new facts, important as they are, bring additional complexity into the subject of fatigue-endurance, and indicate that perhaps more remains to be learned about endurance than is yet known. For instance, there is the possibility that in long-time service many materials in a hardened condition have not the same advantage over soft material that they exhibit in static tests—a possibility of such importance that it would justify extensive and thorough research. The relation between fatigue and corrosion is a factor here; but this relation as explored to date appears full of obscurities. A special feature of interest in the latest studies is the attempt to investigate the strength of lead cable-sheath alloys by endurance testing. One of the elements of attack upon such sheaths in overhead service, it is said, is the vibration from traffic on the adjoining road pavement, which traveling up the pole on which the cable is supported sets up rapid variation of stress in the cable. Practice is said to show that this vibration contributes to the ultimate failure of the sheath, in spite of the fact that the service of an overhead telephone cable would ordinarily be considered purely static. The case seems to represent one instance of static loading to which fatigue endurance must be applied as a criterion. Future investigation of fatigue and of service failures is likely to show more instances of this kind.

Where Trouble Can't Survive

SAID the head of a large manufacturing concern, recently, "We can't prevent trouble developing around our plant but we can make the conditions such that it will not survive." This statement has much meat in it for the superintendents of large construction jobs. The manufacturing plant referred to has made a notable record during the past quarter century for freedom from labor troubles and its labor turnover has been surprisingly low. While the temporary nature of construction jobs makes the labor problem somewhat different from that in manufacturing plants, they have much that can be done in common to keep down the turnover. Both can eliminate unsafe structures and defective tools and equipment, protect men working in exposed positions, and provide adequate sanitary arrangements and proper medical care. In construction camps, comfortable living quarters and entertainment facilities for the men during idle hours may be provided and wholesome food served in clean and cheerful mess halls. A construction camp, like an army, moves on its belly and nothing can destroy the morale of either like poor cooks. That many contractors recognize the money value of adequate construc-

tion camps is shown by such camps as that of Stone & Webster at Conowingo, or of the Dixie Construction Co. at Cherokee Bluffs, camps that are an eye-opener to those who have been used to construction camps only one step removed from a back-woods lumber camp.

Punishment for Montreal Typhoid

A LARGE percentage of the 5,000 victims in the Montreal typhoid epidemic, which now seems to be slowly burning itself out, partly for lack of fuel, were so young—a third of them being under ten years of age, and many under twenty—and so many others were so little aware of their dangers, that the epidemic is a slaughter of the innocents, unparalleled in kind if not in magnitude.

Very properly, the admirable report on the epidemic by the U. S. Public Health Service, printed elsewhere in this issue, does not attempt to fix personal responsibility for the epidemic—leaving that for the report of the provincial bureau of health which may be expected in a few weeks. The Public Health Service report does make perfectly clear that the epidemic was due to inadequate sanitary control of the milk supply of Montreal, a control which, like other health-protective work in Montreal, is still inadequate. It expresses a strong conviction, based on careful study, that whereas all the milk supplied by the incriminated dealer was supposed to be pasteurized, much of it, through "advertence or inadvertence," was passed to the consumers without pasteurization, and this during the recrudescence as well as the first period of the epidemic.

Although the Public Health Service does not so state in as many words, its report shows between the lines that control of the Montreal milk supply was so inadequate that no one knows, and probably no one ever will know, just how the milk became infected—although many unobstructed channels of infection existed, and still exist, due to poor sanitary conditions in the milkshed.

From the Public Health Service report and from other sources of information and opinion, it appears clear that while the local health officer did all he could to control the epidemic, his efforts were largely futile, due to lack of funds and staff and hindrance rather than support by the city council. For these or other reasons it appears that the incriminated milk was never excluded from sale *by the city authorities,* but was distributed until well into the second outbreak, and excluded then by the provincial health authorities only after the executive committee of the city council had dilly dallied for three days with a provincial order to exclude the milk.

Still later, in a debate of some hours in the city council, the report of which filled several columns of the Montreal *Gazette* of May 24, the chief concern of the dominant speakers was to justify non-action as to shutting out the incriminated milk, to belittle the epidemic and even to deny its existence, and to hush up all reports that might keep tourists away from Montreal. A possible suit for damages by the incriminated milk dealer was urged as justification for not ordering the suspected milk supply excluded. When particularly hard pressed by one of the few councilmen who raised protests, the chief spokesman declared, "I didn't invent typhoid," an utterance that deserves to go down in the history of sanitation.

What the law in the Province of Quebec may be as to suing a municipality for damages for sickness and deaths caused by such an epidemic we do not know. If there ever were reasonable grounds for such a suit they exist in Montreal. In addition to suits for damages, others might well be brought against members of the city council for malfeasance and misfeasance in office. A particular object for inquiry should be why exclusion of the incriminated milk awaited action by the provincial authorities, and whether, and if so then by whose connivance, infected milk was sent to Montreal without pasteurization.

Until such questions are answered and until the health director of Montreal is given adequate funds, staff and legal authority, well backed by the city council, to control the milk supply and in other ways to safeguard the health of Montreal, visitors and prospective visitors to that city will do well to follow the advice given in the report of the Public Health Service. Put more bluntly, that advice is to keep away from Montreal. That is not only the safest way but it will mete out some of the punishment which the city and its authorities deserve for permitting such a blot on modern sanitation and health protective work to occur and for doing so little, and that by compulsion, to wipe it out.

Overtaxing the Eyes

IN THE daily more obtrusive question of making road traffic safer (or less dangerous), the increasing tax on the vision and attention of the driver is coming to be a serious matter. Are we making the eyes responsible for an undue proportion of road safety? There is a limit to the burden that can be put upon a single sense. Light signals, by day and by night, have multiplied so much that they alone monopolize the eyes of the man at the wheel. Heavy additional demands are put upon them by blind corners, side roads and private driveways, rough grade crossings, bad shoulders, curves of unwarned sharpness, traffic officers, and at night the glaring evil of bad headlights. This is a threatening total, quite aside from such minor distractions as guide boards and the multitude of advertising signs. If we have not quite reached the limit of dependence on the driver's power of vision, we are very close to that limit. For a change in this state of affairs, we have to look in the end to improve engineering in the adjustment of the road to operating requirements.

Pending accomplishment of this long-time remedial work, however, there are administrative measures by which the existing situation can be improved, for the attempt to make roads safer has so far overshot its mark that this in itself is a source of danger. First in order of urgency is elimination of those warning signals that satisfy local pride rather than safety requirements, or such as can be made unnecessary by minor change in layout or routing. Dangers at blind corners and side roads can also be dealt with in a measure, by establishing (and *enforcing)* a thoroughfare-stop rule. A genuine effort on the part of motor vehicle departments to deal with bad headlights is also capable of bringing about a large improvement. Active work in such directions as these would accomplish enough to give a breathing spell, pending the attack on major problems—inadequate two-lane main roads, grade intersections, and narrow bridges with dangerous approaches. These larger tasks of safety engineering lie uncomfortably close ahead, and are formidable in the extreme. They ought not to be confused and complicated by minor troubles of readily preventable kind which place an additional tax on the road user's keenness of vision and presence of mind.

The First of a Series on
HIGHWAY MAINTENANCE

County Maintenance Under State Control

By J. T. Donaghey
Formerly State Highway Engineer of Wisconsin

MAINTENANCE administration and the broader problems of highway maintenance are pressing public roads officials for consideration as the mileage of maintained road constantly increases. What are the relative advantages of direct state maintenance and county maintenance under state control? With the creation of enormous assemblages of maintenance plant and machinery how should it be conserved, kept in repair and replaced? Should the state perform its maintenance work altogether with its own forces or can it advantageously award a part of the work to contractors? With a growing demand for year-around roads what is the problem of winter maintenance and how should it be solved? And finally with the contribution by the United States of large sums in federal aid, what functions and control are exercised by federal road officials? All these inquiries press for a reply.

This series of seven articles presents the answer as it is conceived by leading highway engineers and administrators.—*Editor.*

A STATE highway system should interconnect every county seat in the state, and every city and village having a population of 1,000 or more. It should offer full access to all agricultural and industrial centers and to the principal scenic and resort localities within the state, and it should connect with the principal highways in all surrounding states. Prior to the world war, there were practically no states which had a state highway system that was systematically marked and maintained. In several states, work had progressed quite far in the construction of certain main highways, but in no state was there a system completely marked and maintained for through traffic.

A demand for through highway service has been brought about by the low-priced automobile which has put ownership within the reach of practically every American family. Due to the rapid growth of motor vehicle production and a parallel demand for the use of these vehicles, the highway officials of the various states have been confronted with the problem of providing a roadbed over which motor vehicles can operate with safety and comfort and of developing an organization that would adequately construct and maintain the highways sufficiently well to provide through highway service with facility and economy. Each state was presented with the problem of selecting a state system and a plan under which it could operate most efficiently. The practice of indiscriminately scattering the expenditures over many roads of varying importance with no definite goal in mind had to be discontinued. It was evident that a definite plan of concentrated construction and maintenance on a well-laid-out highway system must be adopted to meet the growing demands of the motor vehicle.

Selecting a Plan—In selecting the state highway system in Wisconsin, a very careful preliminary study was made of the whole state and its possible future development. The main routes were chosen from the best information available. This was followed by a careful reconnaissance survey in the field. Prior to final selection, hearings were held at all county seats, where all interested had an opportunity to discuss and present their views as to the proper route locations in their community. In a great many cases, changes were made as the outcome of the hearings. By adopting this policy, a system of highways was finally selected that fills the general traffic demands of the state.

Two general plans of maintenance were open for consideration: (1) a plan whereby the state would maintain the system by state forces without co-operation of the local units of government, and (2) a plan under which the county would maintain the system under the general supervision and direction of the state highway department.

Wisconsin selected the latter plan, and in so doing the State Highway Commission kept in mind the fact that highway work had been carried on, up until this time, largely by county forces. The counties were well equipped with roadbuilding equipment. They were also well supplied with experienced labor and foremen in road building work. Aside from the above reasons, the following advantages were evident: By placing the responsibility of maintaining and improving the highways on the local units of government, the interest and pride of the local people would be developed to such an extent that good results could be assured. It was believed that this plan would also develop sentiment for good roads in general throughout the local communities. It was also determined that the entire state system, whether improved or not, must be maintained. Undoubtedly this last-named factor was the most important one in the development and improvement of highway transportation in Wisconsin. It is held that the establishment of a preferred system of highways by any unit of government should carry with it the immediate maintenance of that system by the establishing unit. It cannot be overemphasized that a state system of roads should not be laid out unless real state control of its maintenance is also provided.

Had Wisconsin chosen the first plan, it would have been necessary at the outset to spend large amounts of money for equipment. It also would have been necessary to enlist the services of many of the county employees who had already gained experience in road building. This, to a certain degree, would have antagonized the local highway officials and probably would have resulted in a slowing up of the forward movement for good roads. Fortunately, the plan adopted has worked out most satisfactorily, and when one takes into consideration the fact that the work has been carried on through 71 county organizations working under the general supervision of the state highway department, very excellent results have been obtained. The co-operation between county and state organizations has been

most gratifying. The maintenance organization which has functioned in Wisconsin since 1918 is as follows.

Organization for Maintenance—The State Highway Commission consists of five members, three of whom are appointed by the Governor for six-year terms, one term expiring the first Monday in February of every odd year, and two *ex-officio* members, the dean of the college of engineering of the state university, and the state geologist. All members of the commission receive their actual and necessary expenses incurred by their duties, but have no salary, except that appointive members of the commission may receive a sum not to exceed $5 per day, in addition to expenses, when attending meetings of the commission.

The duties of the state highway commission are in general to carry out the provisions of the federal-aid highway law in so far as it relates to Wisconsin and the various laws of the state having to do with state aid in the construction and maintenance of highways. The commission also has supervision over the maintenance of the state trunk highway system and is required by

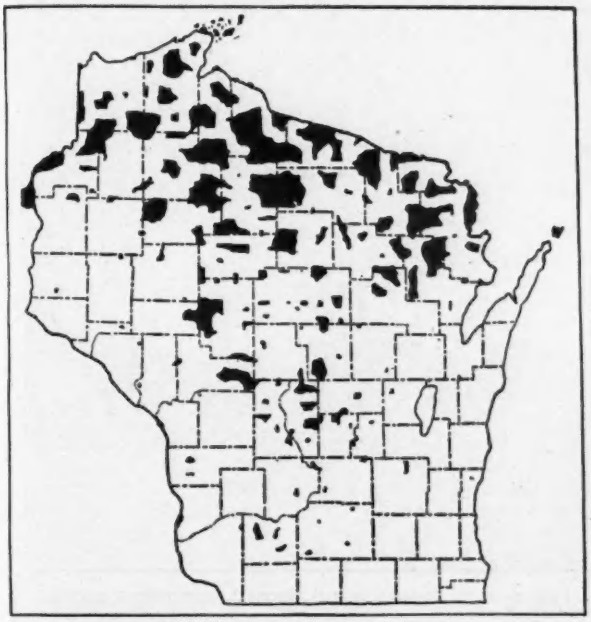


FIG. 1—AREA OF WISCONSIN SERVED BY PATROL MAINTAINED HIGHWAYS

All of Wisconsin except the areas shown in black is within three miles of a patrol maintained highway. This area contains less than 8 per cent of the area of the state. It is composed chiefly of sandy or marshy land and cut-over sections. Less than 2 per cent of the population of the state lives within this 8 per cent area.

law to prescribe the specifications and regulations to govern such maintenance. The maintenance allotment from the state to the county may be withheld in case the maintenance work is not performed in accordance with these regulations, and the state may perform the work directly.

The authority of the state highway commission is exercised through its engineering staff. The commission meets regularly, on the first Tuesday of each month, to consider such matters in connection with the administration of its work as may properly come before it. The determinations of the commission in these matters are carried out by its engineers, to whom it has delegated the necessary authority. The chief engineer of the commission is called the state highway engineer. Other members of the staff, subordinate to the chief engineer but in important capacities, are the engineer secretary and the heads of the several departments, namely, the design engineer, the construction engineer, the maintenance engineer, the traffic engineer, and the chief accountant. The state is divided into nine districts, each of which is under the charge of a division engineer. Each division engineer has a maintenance engineer to look after the maintenance work in the counties comprising his division. The division organizations work under the general supervision of the central office.

County Government Organization—To understand the Wisconsin plan, it is necessary to explain first that

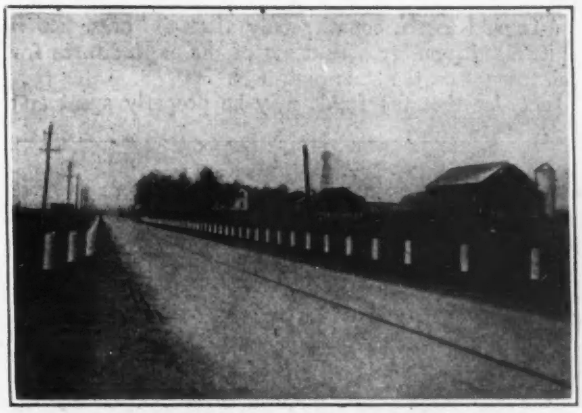


FIG. 2—WELL MAINTAINED CONCRETE ROAD IN SOUTHEASTERN WISCONSIN

the county government consists of a county board made up of a member from each township and village and one from each ward of all cities within the county. This results in a county board in many counties containing sixty members; the average is forty-five.

The county highway organization consists of a county highway committee and a county highway commissioner. Each county board at its annual meeting is required to select a committee of not less than three, nor more than five, persons to serve for one year or until their successors are selected.

The county highway committee has charge of the execution of all construction and maintenance of highways and bridges, for which provision is made by the county board. The members are reimbursed for their actual and necessary expenses incurred in the performance of their official duties. The actual execution of the work is in the hands of a county highway commissioner elected by the county board. He is the executive highway officer of the county. He has charge, under the direction of the county highway committee, of the construction of highways built with state or county aid, and of the maintenance of all highways maintained by the county. His salary is fixed by the county board, subject to a minimum specified in the statutes, and he is also entitled to his necessary traveling expenses out of the general fund of the county. The board is required to provide him with suitable offices and with the assistants necessary for the proper performance of his duties.

Frequent meetings are arranged between the county committee and the state representative in order to plan the work in advance. In this way, the problems are worked out together to the advantage of all concerned, and very little dissension has arisen through this plan.

Origin of Maintenance Funds—Under the Wisconsin laws, the funds for the maintenance of the state high-

way system are provided from the receipts of automobile license fees and a gas tax. The mileage on the 10,000-mile state highway system is classified as follows: 2,300 miles federal primary roads, 3,200 miles federal secondary roads, and the balance, or 4,500 miles, ordinary state highways. The laws specify that each mile of federal primary road is entitled to receive $500 annually for maintenance purposes. Each mile of federal secondary road is entitled to receive $400 per mile annually, while the balance of the state highway system is entitled to receive $300 per mile. This makes a total of about $4,000,000 for the maintenance of the state highway system. The money is held in the state treasurer's office and is paid to the counties only after the presentation of itemized monthly statements of the expenditures for maintenance on the state highways.

In order that the funds may be properly spent and

FIG. 3—TEAM PATROL BLADING A GRAVEL ROAD

that efficient highway service may be rendered, the maintenance funds are budgeted each year. In the fall of the year a representative of the commission, usually the division engineer or his maintenance assistant, goes over the state highways through each county accompanied by the county commissioner and the county committee. At that time they outline the work to be carried on during the following season, setting aside specific amounts for improvement of bad sections; also for resurfacing of worn-out roads, the widening of grades, the elimination of bad alignment, and many other improvements. A definite set-up is made for general maintenance for betterments, reconstruction, patrol superintendence, repair of bridges and other structures and other miscellaneous needs. A sufficient amount is reserved to take care of emergencies during the spring break-up and floods. In any event, the county is not free to spend the funds unless authority has been granted by the state highway department, and in this way a very close check is kept on all expenditures made by the county. The county officials, knowing that all requisitions must be approved by the commission before they are paid, do all they can to co-operate to the fullest extent.

The main cog in the maintenance of the state highways is the individual patrolman. In most instances, the patrolman on any particular section is a resident of the community in which he works, and it is believed that this is another thing which has strengthened the plan adopted by Wisconsin, namely, to place the responsibility on one who naturally has pride in his community and will do all he can to give the best of highway service.

Co-ordinating Agencies—To co-ordinate the work among the various agencies in the county and state, county road schools are held each year at the county seats, usually at the beginning of the season, in which all subjects pertaining to the maintenance of the highway are discussed. At these meetings, the patrolmen are given a chance to speak freely and outline their ideas as learned from experience and to discuss with other patrolmen the advantages of carrying on their work according to the best methods. At this time when all the patrolmen are assembled, general instructions are issued to them by the commission's representative. Any doubtful points are discussed and agreed upon. The county road schools are primarily for the benefit of the patrolmen, but they also serve as a co-ordinating influence for all those interested in highway development.

In order to discuss highway problems from a statewide viewpoint, an annual state road school is held at the state capitol. The law requires that every county committee and highway commissioner must attend these meetings. Citizens interested in highway work are invited to, and in many cases attend, all sessions of the road school. It is believed that the county road school and the annual state road school have been an incalculable influence in the development of uniform maintenance.

Results and Future Prospects—Probably one thing

FIG. 4—MOTOR GRADER PATROLS ARE INCREASING

that speaks more for the system employed than does any other is the fact that county trunk systems patterned after the state system have been developed in all counties, and, in a great many instances, the practice has extended down to the town roads. The county trunk systems today total approximately 12,200 miles of secondary highways which are systematically maintained and marked and signed in the same manner as the state highways. Many of the towns have developed town systems and have placed patrolmen on the highways to keep them maintained at all times. It is believed that the results obtained on the state highway system through the plan adopted have been largely responsible for the improvement of the county trunk system and the town roads.

Wisconsin's plan of highway development includes not only the permanent improvement of her main trunk routes, but also makes special provisions for the handling of existing traffic on temporary inexpensive type highways properly maintained. The principal objective is to satisfy the traveling public and the system is considered as having failed if the traveler is not properly cared for. Especially is this true during the construc-

tion season when the tourist is confronted with the sign "Road Under Construction—Temporary Route."

The temporary route has been made a part of the highway business, and it is planned for with the same regularity and exactness as the construction project. In planning the next year's construction work, those projects that must be closed to traffic are given due consideration and a temporary route is prepared for through traffic before the construction of the project is started. Maintenance funds and in many cases funds from the construction project are used to improve the temporary route. A plan has been worked out where the county

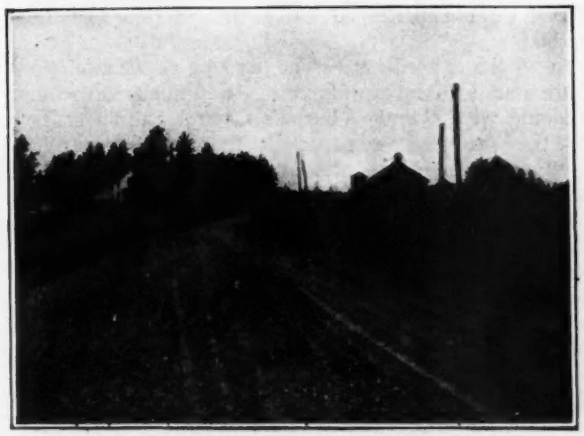


FIG. 5—NORTHERN WISCONSIN GRAVEL ROAD

prepares the temporary route the year before construction is contemplated. As soon as the regular route is closed, the temporary route is marked and becomes the legal trunk highway, as far as maintenance is concerned.

The public as a whole is very well pleased with the results obtained; but as modern civilization progresses, the demand is ever increasing for more and better transportation over the highways. It has been found in the short time that maintenance work on a systematic basis has been carried on in Wisconsin, that the methods employed six or eight years ago will not suffice for present-day transportation. The greater part of the maintenance work has in the past been carried on by horse-drawn equipment, but during the last two or three years a rapid change has been taking place in favor of the motor-driven maintenance equipment. During the past seven years all highway traffic on Wisconsin state highways has increased by 370 per cent. This percentage is in number of vehicles only; there are no definite figures as to the growth in volume of freight handled over the highways, or as to the increased speed of traffic in general. It is safe to say, however, that the average speed over the present-day highway is probably 50 to 75 per cent greater than it was in 1918, when the system was first taken over for maintenance.

Nothing has been said thus far about the marking and signing of a state system of highways. It is believed that the importance of a well-marked system cannot be over-stressed. The proper marking of the state highway system in Wisconsin was one of the prime factors in bringing the tourist to this state. The maintenance, marking and signing of the state system, coupled with the state's natural beauty and resources, have made the tourist business one of great importance. The annual revenues now reach more than $100,000,000.

Much can be said for the plan under which Wisconsin has been operating for the past eight years. It has weaknesses, it is true. No system can be perfect, but it is believed that satisfactory highway service has been rendered during this time.

Traffic conditions are rapidly changing and to say at this time that this plan should be continued or be discontinued in favor of another would be hazardous. An intimate contact has been kept between the county and the state, and all matters of legislation have been worked out to the advantage of the counties and the state. After all, a state highway system cannot be called successful unless the secondary and local roads experience a parallel development commensurate with their importance as arteries of traffic. A review of the past eight years shows that this condition is rapidly coming about in the counties and local units, and it is believed that the people as a whole are well satisfied with the results. The maintenance of the state highway system by the counties under

FIG. 6—BITUMINOUS SURFACE-TREATED GRAVEL ROAD IN CENTRAL WISCONSIN

the supervision and direction of the state highway department was the initiatory step toward the development of comprehensive county and town highway systems which are now paying dividends many-fold. It is doubtful if this could have been accomplished in eight short years by a state organization directed wholly from the state capitol.

The state highway system when taken over for maintenance in 1918 consisted largely of narrow unimproved roads with a few miles of macadam and concrete, a fair mileage of light gravel surfacing, and a large mileage of dirt road. Due to the concentration of efforts, practically all state highways have been widened and about 60 per cent of the mileage is surfaced with a suitable temporary material, while 25 per cent is surfaced with a durable pavement, mainly cement concrete. The widening and temporary surfacing of the greater part of the mileage has been done through maintenance operations, the counties contributing to supplement the state funds.

The attached map shows plainly the broad and general traffic service rendered the people of Wisconsin by following this co-operative policy. It may be possible that a centralized state organization could give quicker service in certain cases, but I do not believe the service would be as well distributed or as cheaply given.

[*The next article in this series will be on "State Maintenance Independent of Counties," by W. F. Rosenwald, maintenance engineer, Minnesota.*—EDITOR.]

Deep Steel Sheetpile Cofferdams at Arlington Bridge

Large Piers Founded on Rock Within Single-Wall Cofferdams—Sheetpiles Sealed to Rock by Grouting

By Charles Carswell
Assistant Engineer, Arlington Memorial Bridge Commission, Washington, D. C.

FOUNDATION work of unusually interesting character is nearing completion for the Arlington Memorial Bridge across the Potomac River at Washington, D. C. The principal features of the work are (1) the use of single-wall steel sheetpiling cofferdams 40 ft. deep and of large area, maximum 64x140 ft., (2) the sealing of the sheetpiling by grouting on extremely irregular rock surfaces, and (3) excavation of the cofferdams to rock before construction of the bracing.

The Arlington Memorial Bridge is to be a multiple-arch structure of reinforced concrete faced with granite masonry, with a bascule draw span over the river channel. Eight arch spans and the draw span comprise the main bridge structure, which connects the Washington shore with Columbia Island. Access from the island to the Virginia shore will be had by two smaller spans similar in construction and appearance to the main arches.

The foundations for the main bridge structure consist of six intermediate piers, two shore abutments, and two abutments at the draw span. The piers range from 38x128 ft. to 41x131 ft. in plan. The shore abutments are each 60x96 ft., and the draw-span abutments are each 60x136 ft. All the foundations are on bedrock, which has a sharply defined and very irregular surface, overlain by fine sand and mud to an average depth of 20 ft. The average elevation of the bottom of the foundation masonry is about 37 ft. below mean low water in the river, but the irregularities in the rock surface make variations of approximately 6 ft. in the elevations at the bottom of each pier and in many cases produce a drop of as much as 1 ft. over the width of a single piece of 14-in. sheeting.

The methods for handling the work, as to both general procedure and detailed design of the cofferdams, were developed by the contractor. Single-wall braced cofferdams of rectangular section were employed, the width and length being in general 4 ft. greater than the dimensions of the completed masonry, so that the maximum size of cofferdam (for the draw-span abutments) was 64x140 ft., as already stated. Lackawanna arched-web piling, of 14x⅜-in. section and in lengths of 46 ft., was used for the entire work. All cofferdams except that for the Washington shore abutment were constructed as river piers in water from 10 to 20 ft. in depth.

Construction Procedure—As the first step in construction, wooden range piles were driven to establish the bridge line and the pier locations. Wooden piles and batter piles were then driven to support waling pieces for each cofferdam, and the sheetpiling was assembled and driven to rock. Wheat grain was rammed into the joints to assist in securing watertightness.

In the handling of the first two cofferdams, considerable difficulty was caused by blow holes at the bottom of the sheeting because the piling could not be driven to tight seal on the irregular rock surface. Grouting was then resorted to in order to seal the cofferdam on the rock, the procedure consisting in forcing grout to the bottom on the outside of each piece of sheeting. The grout was injected first at every fourth pile, and the intermediate sheets were then grouted successively around the cofferdam. From 1 to 4 batches of grout, of 3 cu.ft. to the batch, were placed at each piece of sheeting; the operation was continued until soundings indicated that the end of the pile was surrounded completely, up to the high corner, with concrete. These grouting operations proved thoroughly satisfactory, and no difficulties from blows were experienced after the adoption of this method.

In all the cofferdams except that for the Washington shore abutment, excavation was carried down to rock by dredging with clamshell buckets through the water, before the bracing was constructed. This method permitted rapid and economical excavation and proved satisfactory in all cases.

For bracing the cofferdams, timber cribbing was used, framed of 12x12-in. timbers spaced 9 ft. on centers both longitudinally and transversely. Double wales were used for the lower five tiers of the bracing, and at all wales hardwood bearing blocks were provided for connection with the horizontal timbers. The bottom four tiers of the cribbing were of yellow pine with oak bearing blocks, while the upper tiers were of fir with oak bearing blocks.

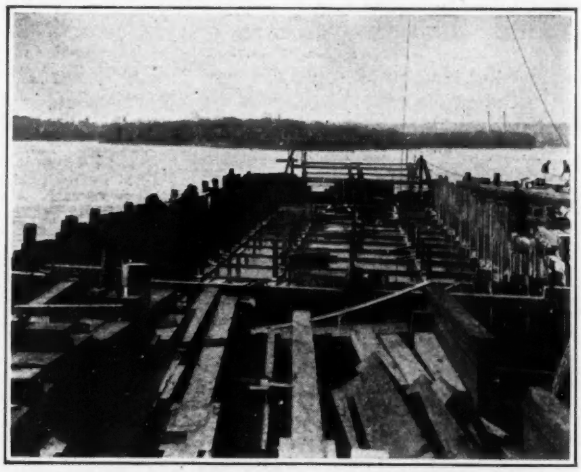


FIG. 1—PIER 4 COFFERDAM OF ARLINGTON BRIDGE
View upstream. Steel sheeting 46 ft. long driven to irregular depths because of irregularity of rock surface. Bracing being assembled and sunk, after completion of clamshell dredging to rock.

Vertical crossbracing was provided by 2-in. planks spiked on the two central longitudinal bents and on the two end transverse bents of the cribbing.

The successive tiers of the cribbing were framed inside the cofferdams, at the water surface. A clearance of 1 to 2 in. was allowed on each side. As the cribbing was built up, it was sunk to the rock, sand ballast being used when required to facilitate the sinking.

After the bracing had been sunk to the rock surface, wooden piles were set at the intersections of the bracing timbers, and the timbers bolted to the piles in order to secure support for the cribbing. Pumping was then started and the cofferdam unwatered. A 16-in. centrifugal pump was used to lower the water level approximately 22 ft., and then two 6-in. pumps were installed

inside the cofferdam and staged down as the water level was further lowered.

With the cofferdam unwatered, excavation of the low pockets in the rock was completed by hand labor and the

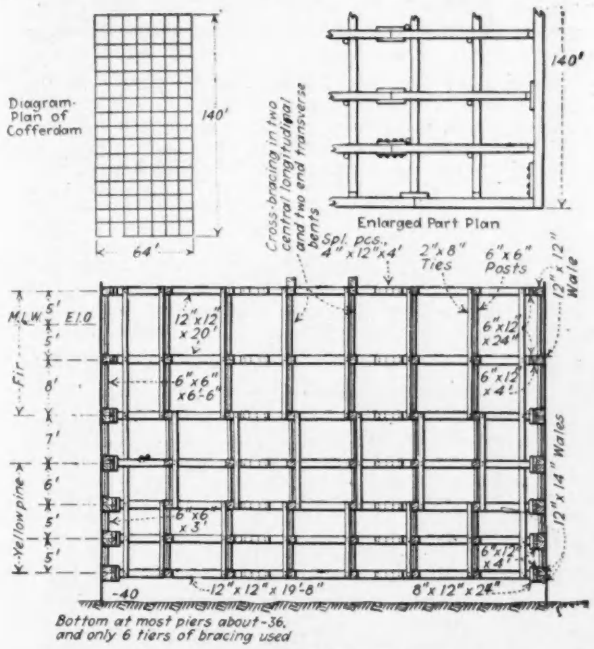


Diagram Plan of Cofferdam
140'
64'
Enlarged Part Plan
Cross-bracing in two central longitudinal and two end transverse bents
Spl. pcs. 4" x 12" x 4'
2" x 8" Ties
6" x 6" Posts
12" x 12" Waler
M.L.W.
E.I.O.
Fir
Yellow pine
12" x 12" x 20'
6" x 6" x 6'-6"
6" x 12" x 24"
6" x 12" x 4'
6" x 6" x 3'
12" x 14" Wales
-40
12" x 12" x 19'-8"
8" x 12" x 24"
Bottom at most piers about -36, and only 6 tiers of bracing used

FIG. 2—COFFERDAM CONSTRUCTION
Most cofferdams had only six tiers of bracing, rock being found several feet higher than here shown.

surface cleaned thoroughly by hosing and scrubbing. Channels were cut to carry the water to a low point and pumping was continued at this point until the bed had been concreted. Irregularity of the surface in some cases made necessary the use of two drainage areas. Very little pumping was required to handle the slight seepage through the sheeting and the groundwater springing through the rock. The cofferdam joints were in all cases satisfactorily tight, and after the grouting procedure had been developed for sealing the bottom of the sheeting no delays were occasioned by blow holes. In the few instances when blow holes developed the inflow of material was so small that it was handled without interfering with the laborers working on the bottom.

For the Washington shore abutment, the method of bracing the cofferdam as it was excavated was adopted, because of the earth pressure on the shore side. Unequal pressures brought upon the bracing as successive sections were framed in place resulted in some distortion of the cribbing for this abutment. The framing of the entire bracing before the pressure on the cofferdam was brought upon it, as used on the other piers and abutments, avoided this trouble and at the same time secured considerable economy in the handling of the excavation and of the framing work.

After the detailed methods had been developed in the handling of the first two cofferdams, the operations of pumping out the water, cleaning the bed and sealing it with the first pour of concrete were completed in from 10 to 14 days.

As the concrete was deposited, the piles provided for the support of the cribbing were cut off and the horizontal timbers of the cribbing were removed, special timber struts being provided as the masonry was built to successive heights, for support of the upper tiers of the bracing.

Construction Plant and Personnel—The contractor's plant for handling the work was designed to utilize water transportation for all materials, and floating equipment was used throughout to secure flexibility. The entire concreting plant, comprising mixer, storage bins for cement, mixing hoppers, chuting tower, and boilers and pumps, was located on a barge. Cement, sand and gravel were received in bulk on barges and handled directly to bins and hoppers. All the concrete was chuted into place.

The piers and abutments are being constructed by H. P. Converse & Co., under a contract awarded in April,

FIG. 3—BRACING OF PIER 3 COFFERDAM
Modern piles supporting the bracing were cut off and replaced by posts after bottom was concreted.

1926, by the Arlington Memorial Bridge Commission, Colonel U. S. Grant, 3rd, executive officer. The work has been executed under direct supervision of H. P. Converse, with G. A. Follett as superintendent of construction.

English Filter Plant Recovers Wash Water Wasted

Clarification of the wash water and its passage through the plant again cuts the wasted water to a low percentage in the new Sandsfield mechanical filtration plant of the South Staffordshire water-works in England, according to a description of the plant in London *Engineering* for May 27, 1927, p. 630. Actual observations over a period of one month showed the percentage of wash water wasted to be 0.0304. Wash water passes from the filters into tanks and, as the sludge settles out, the clear water is pumped back into the raw water entering the plant. The sludge is passed through presses which expel all moisture and form the sludge into cakes. These cakes are then carted away. The normal amount of wash water wasted in British plants, according to the article, is from 1 to 2 per cent of the amount filtered. The contractors for this plant guaranteed that the amount of wash water wasted should not exceed 1 per cent and agreed to a penalty of £250 ($1,200) for every 0.25 per cent above 1 per cent and a corresponding bonus for each 0.25 per cent below that rate.

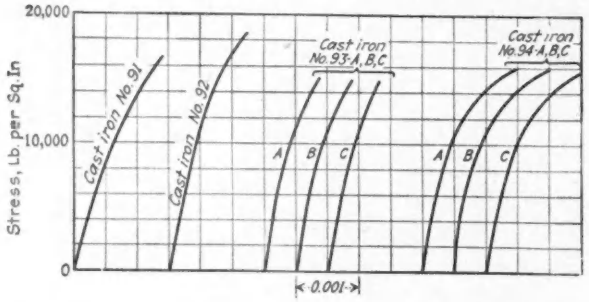
Research in the Fatigue of Metals

Papers Presented Before American Society for Testing Materials in June—Fatigue of Cast Iron and of Telephone-Cable Sheathing—Corrosion-Fatigue of Duralumin and Other Non-Ferrous Metals

Fatigue Endurance of Cast Iron

By H. F. Moore and S. W. Lyon
University of Illinois, Urbana

During the pat year there have been made at the University of Illinois a number of fatigue tests of specimens of gray cast iron. Four different castings furnished the source of supply for test specimens: (1) A section of 6-in. centrifugally cast pipe bought on the open market; (2) a cylindrical casting 12 in. in diameter with 1-in. walls; (3) a similar casting with 3¼-in. walls, and (4) the inner wall of a double-walled cylinder casting weighing about 25 tons. The various specimens ranged from 1.10 to 1.42 per cent silicon and 0.32 to 0.63 manganese, with total carbon about 3½ and combined carbon ranging from 0.84 per cent for the pipe to



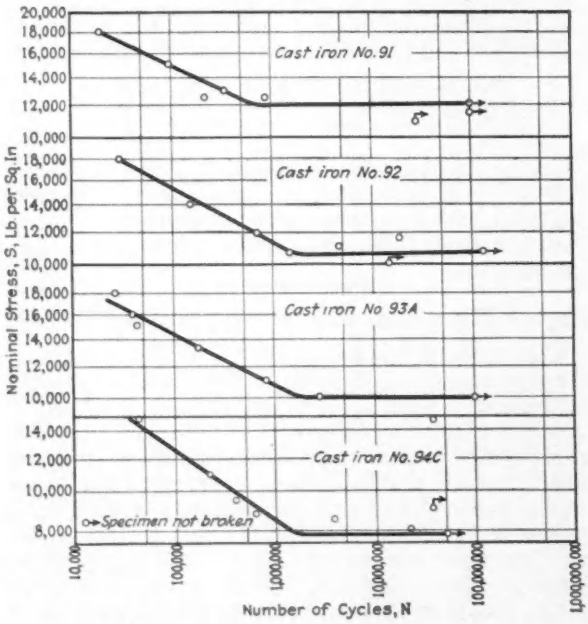
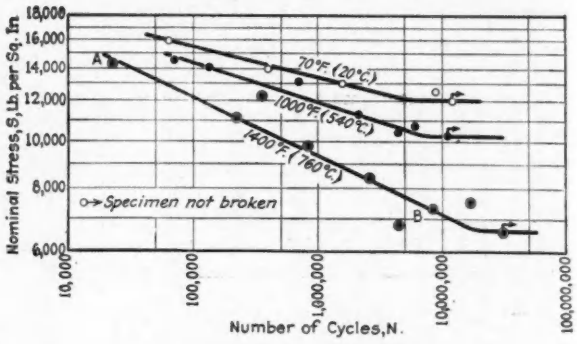

Nominal Stress, S, Lb. per Sq. In.
Cast iron No. 91
Cast iron No. 92
Cast iron No 93A
Cast iron No. 94C
Specimen not broken
Number of Cycles, N

FIG. 1—TYPICAL TENSILE AND ENDURANCE CURVES FOR FOUR CAST IRONS

practically zero for the large casting. Structurally the irons were normal. Tests were made in a rotating-beam machine with central loading.

Fig. 1 shows tension test and endurance test curves. The endurance limits range from 8,000 to 12,000 lb. per sq.in. The endurance ratios are rather low (0.33 to 0.46).

Several special tests were run on the third and fourth irons to study the effect of *understressing* on endurance. This consists of subjecting the specimens to several million cycles of stress just below the original endurance limit. Several experimenters have found that such understressing appreciably raises the fatigue strength of rolled steel, but it



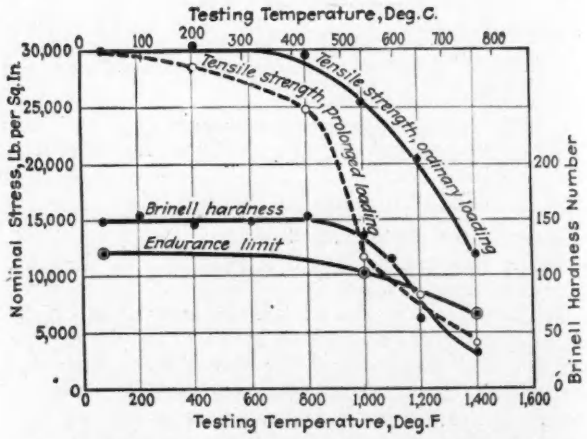


FIG. 2—HIGH-TEMPERATURE STRENGTH AND ENDURANCE OF CAST IRON

has been thought that it would have little or no effect on the fatigue strength of a brittle material. However, the tests showed a very distinct increase in endurance limit of the understressed specimens of cast iron, the increase amounting to 43 per cent in the case of the fourth iron.

The effect of a groove of ⅛-in. radius was studied, but it reduced the endurance limit only 3 per cent, while the effect on steel is 30 to 40 per cent. Evidently the magnitude of effect of groove is no direct function of brittleness. The metals which are either very fine grained or are of a high degree of homogeneity seem to be worse affected by a groove than do the coarser grained and less homogeneous metals.

Tests were also made at elevated temperatures, with results summarized in Fig. 2. They show that the cast iron tested maintains its tensile strength practically constant up to a temperature of about 800 deg. F., but that the drop in strength at higher temperature is rapid. Prolonged static tension tests show that at normal temperature the tensile strength is not affected by the variations in rate of loading, which ranged from a very small value for the prolonged tests to about 2,000 lb. per sq.in. per second for the ordinary tests. At higher temperatures the difference in tensile strength due to rate of loading is most marked. (These prolonged tests do not, however, determine the tensile strength

of cast iron subjected to high temperatures for periods of months or years.) The fatigue limit at high temperatures seems to be greater than the tensile strength under prolonged loading. The knees of the curves at high temperatures occur at a greater number of cycles than is usually the case.

A few tests were made to determine the endurance limit for cycles of stress ranging from zero to a maximum. The endurance limit was 1.48 times the endurance limit for cycles of completely reversed flexure. This result is not widely different from that found in tests of steel.

* * *

Corrosion-Fatigue of Non-Ferrous Metals

By D. J. McAdam, Jr.
Metallurgist, U. S. Naval Engineering Experiment Station, Annapolis

RESULTS of previous investigation of corrosion-fatigue of steel were presented last year. They showed that even slight corrosion simultaneous with fatigue may cause failure at stresses far below the ordinary endurance limit. It was also shown that severe corrosion prior to fatigue lowers fatigue resistance much less than slight corrosion simultaneous with fatigue. The simultaneous influence of corrosion and fatigue may therefore be called corrosion-fatigue. Under corrosion-fatigue, the stress-cycle graph for steel approaches a horizontal asympote which may be called a corrosion-fatigue limit. It was also shown that for any one corrosive agent the corrosion fatigue limit depends on the corrosion resistance of the steel, but apparently depends little, if at all, on the physical properties as determined by an ordinary tension test, with the possible exception of the modulus of elasticity.

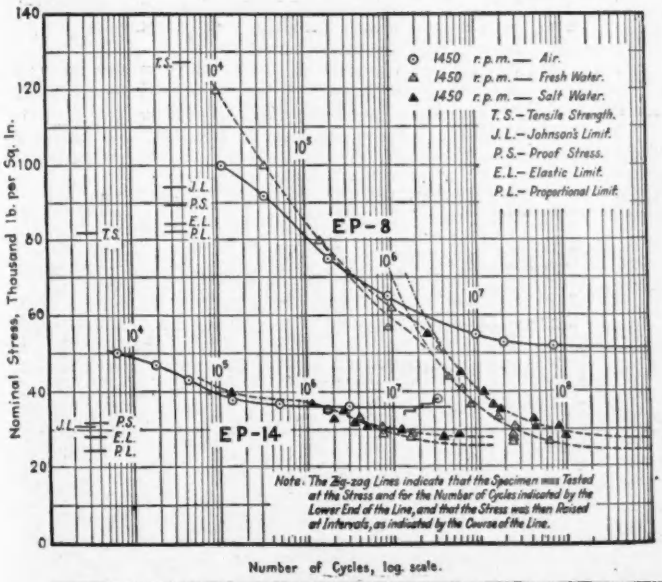
Since that time, preliminary investigation of corrosion fatigue of nickel, copper, nickel-copper alloys, aluminum, and aluminum alloys has been going on. The specimens used were tapered rotating-cantilever specimens, in which the stress varies only about 1½ per cent over a length of 1½ in., so that a comparatively large region may be subjected to corrosion fatigue. Like steel, these non-ferrous metals show a definite corrosion-fatigue limit.

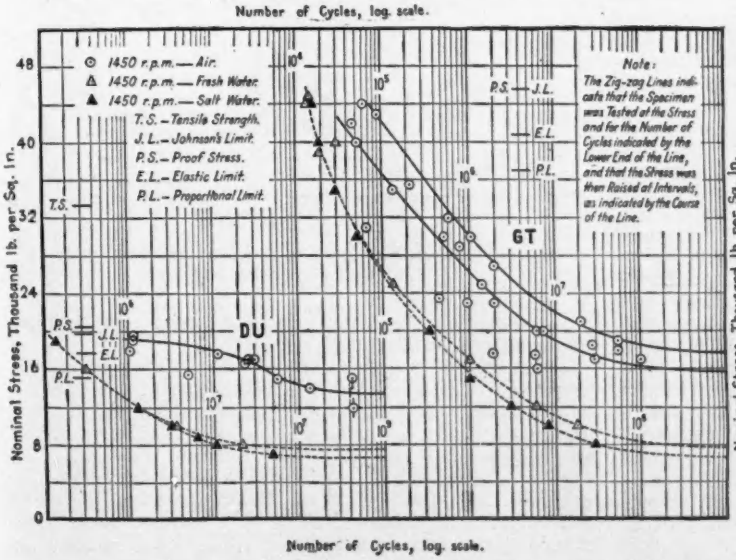
For nickel, the most striking phenomenon is that the corrosion-fatigue limits for strain-hardened and for fully annealed nickel are about the same. Although cold working increases the endurance limit about in proportion to the increase in tensile strength, it has practically no effect on the corrosion-fatigue limit.

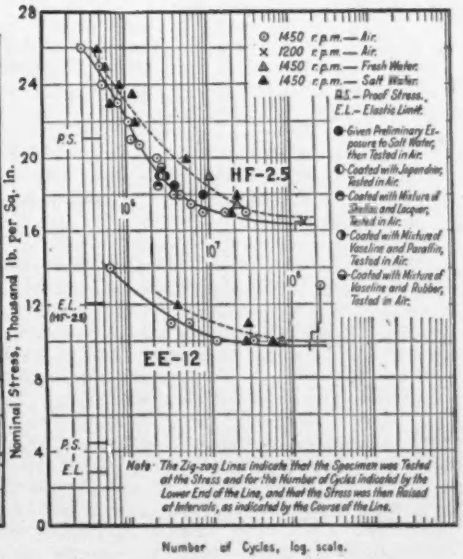
For monel metal also the corrosion-fatigue limits are about the same (Fig. 1, strain-hardened material on the right, fully annealed material on the left). At the higher stresses, the corrosion-fatigue graphs for monel metal are above the ordinary fatigue graphs; in this respect they differ from the corresponding graphs for nickel. The relative positions of the upper parts of the fatigue and corrosion-fatigue graphs depend on the opposing chemical and thermal effects of the water stream.

For 48:48 nickel-copper alloy the corrosion-fatigue limit is no higher than for monel metal and for 21:78 nickel-copper alloy. For the latter, the endurance limit of fully annealed material is well below the corrosion-fatigue limit of the strain-hardened material, in which respect it differs from the other nickel-copper alloys.

In copper (Fig. 3), both strain-hardened and hot-rolled copper tested in water show stress-cycle lines above the corresponding lines representing specimens tested in air. Tests of specimens with various protective coatings seem to indicate that the ordinary fatigue graph has not been influenced by atmospheric


Nominal Stress, Thousand lb. per Sq. In.
Number of Cycles, log. scale.
EP-8
EP-14
T.S.
J.L.
P.S.
E.L.
P.L.
⊙ 1450 r.p.m. — Air.
△ 1450 r.p.m. — Fresh Water.
▲ 1450 r.p.m. — Salt Water.
T.S. — Tensile Strength.
J.L. — Johnson's Limit.
P.S. — Proof Stress.
E.L. — Elastic Limit.
P.L. — Proportional Limit.
Note. The Zig-zag Lines indicate that the Specimen was Tested at the Stress and for the Number of Cycles indicated by the Lower End of the Line, and that the Stress was then Raised at Intervals, as indicated by the Course of the Line.


Nominal Stress, Thousand lb. per Sq. In.
Number of Cycles, log. scale.
DU
GT
⊙ 1450 r.p.m. — Air.
△ 1450 r.p.m. — Fresh Water.
▲ 1450 r.p.m. — Salt Water.
T.S. — Tensile Strength.
J.L. — Johnson's Limit.
P.S. — Proof Stress.
E.L. — Elastic Limit.
P.L. — Proportional Limit.
Note:
The Zig-zag Lines indicate that the Specimen was Tested at the Stress and for the Number of Cycles indicated by the Lower End of the Line, and that the Stress was then Raised at Intervals, as indicated by the Course of the Line.


Nominal Stress, Thousand lb. per Sq. In.
Number of Cycles, log. scale.
HF-2.5
EE-12
⊙ 1450 r.p.m. — Air.
× 1200 r.p.m. — Air.
△ 1450 r.p.m. — Fresh Water.
▲ 1450 r.p.m. — Salt Water.
P.S. — Proof Stress.
E.L. — Elastic Limit.
Given Preliminary Exposure to Salt Water, then Tested in Air.
Coated with Japandar, Tested in Air.
Coated with Mixture of Shellac and Lacquer, Tested in Air.
Coated with Mixture of Vaseline and Paraffin, Tested in Air.
Coated with Mixture of Vaseline and Rubber, Tested in Air.
Note: The Zig-zag Lines indicate that the Specimen was Tested at the Stress and for the Number of Cycles Indicated by the Lower End of the Line, and that the Stress was then Raised at Intervals, as indicated by the Course of the Line.

FIGS. 1-3—ORDINARY FATIGUE AND CORROSION FATIGUE OF THREE NON-FERROUS METALS (MONEL DURALUMIN AND COPPER)

Fig. 1—Monel metal; strain hardened material at right, fully annealed material at left.
Fig. 2—Duralumin; tempered material at right, annealed material at left.
Fig. 3—Copper; cold-worked material treated by low anneal below, hot-rolled material fully annealed above. Full-line curves represent endurance in ordinary tests in air; dash curves represent corrosion-fatigue tests.

corrosion. The elevation of the stress-cycle graph due to the action of water stream therefore seems due not to its chemical action but to its cooling effect.

A rather surprising relationship seems to be brought out by comparison of monel metal and of the nickel-copper alloys. Their corrosion-fatigue limits are practically the same, and the same as for nickel. A possible reason for this constancy would be the presence on the intercrystalline boundaries of small quantities of a second phase having nearly constant composition for the entire composition range of nickel-ropper alloys. Pdrely intercrystalline failure has not yet been observed for these alloys under corrosion-fatigue. Another possible reason is that the observed constancy of the corrosion-fatigue limit may depend chiefly on the electrolytic potential of the alloy.

In the case of aluminum, the evidence seems to indicate that for half-hard and for hard aluminum the corrosion-fatigue limits are about the same, and that for the soft alloy the corrosion-fatigue limit is slightly lower. For aluminum-manganese alloy, also, the fresh water corrosion-fatigue limit is about the same for half-hard and for hard material, but for soft material it appears to be decidedly lower.

INTRINSIC CORROSION-FATIGUE LIMITS OF ALLOYS

Material	Intrinsic Corrosion-Fatigue Limit, Lb. per Sq.In. Fresh Water	Salt Water
Nickel	21,000-24,000	20,000-22,000
Monel metal	21,000-24,000	27,000-29,000
48:48 nickel-copper alloy	21,000-24,000	23,000-25,000
21:78 nickel-copper alloy	21,000-24,000	23,000-25,000
Aluminum	4,000- 5,000	2,500- 3,500
Aluminum-manganese alloy	5,000- 6,000	3,500- 4,500
Duralumin	7,000- 9,000	6,000- 8,000

Duralumin is represented in Fig 2, the curves on the right representing duralumin of unusually hard temper and those on the left fully annealed duralumin. For the tempered duralumin, the results of ordinary fatigue tests were unusually erratic. The wide scatter is not due to variation in the surface finish and is probably not due to atmospheric corrosion. Results of corrosion-fatigue tests, however, are unusually consistent. The corrosion-fatigue graphs throughout a wide range of stress are much below the fatigue graphs. The rapidity with which corrosion-fatigue of duralumin manifests itself is strikingly illustrated by the fact that for a range of stress from 44,000 to 26,000 lb. per sq.in., the range of abscissas of the corrosion-fatigue graphs corresponds to a time range from 10 min. to 1¼ hr. The corrosion-fatigue limits for the tempered and for the annealed duralumin are practically the same; in this respect duralumin is similar to steel. The fact that the corrosion-fatigue limits for duralumin are so low emphasizes the importance of protective coatings for this material.

The fact that for carbon steels and for all alloy steels, except corrosion-resistant steels, the corrosion-fatigue limit varies surprisingly little with composition and heat treatment, and the fact that for each increase in corrosion resistance by addition of elements such as chromium and nickel there is an increase in the corrosion-fatigue limit first suggested the idea that for each metal and alloy there may be an intrinsic corrosion-fatigue limit depending chiefly on the corrosive agent and on the corrosion resistance of the metal. This hypothesis received support when it was found that for nickel-copper alloys the corrosion-fatigue limit is practically unaffected by cold working. It received additional confirmation when it was found that for duralumin the corrosion-fatigue limit is practically unaffected by heat treatment. And there are yet other alloys, each showing constancy of the corrosion-fatigue limit under varying conditions of cold working and heat treatment. Aluminum and the aluminum-manganese alloy are the only alloys yet encountered for which the corrosion-fatigue limit is considerably affected by cold working. Even for these apparent exceptions, however, the increase in corrosion-fatigue limit by cold working is probably confined to the slight amount of cold working necessary to raise the elastic limit until it no longer restricts the corrosion-fatigue limit.

Even if, as seems incredible, all the examples of constancy of the corrosion-fatigue limit are merely coincidences due to the accidental balancing of two opposing influences, nevertheless for all practical purposes it may be considered true that these alloys have intrinsic corrosion-fatigue limits which are realized in practice only if there is no restriction due to elastic limit or endurance limit. The table given lists the approximate intrinsic corrosion-fatigue limits of some alloys.

* * *

Fatigue of Telephone Cable Sheaths

By John R. Townsend
Bell Telephone Laboratories, Inc., New York City

A FULL-SIZED telephone cable has an overall diameter of 2⅜ in., a lead-antimony sheath ⅛ in. thick, and weighs about 7½ lb. per foot. Aerial cables, suspended from a galvanized steel strand by rings spaced about 16 in. apart (at poles the spacing is reduced), are subject in service to varying stresses due to several causes, such as wind swaying the cable, load shocks transmitted through the supporting structures, and temperature changes, daily and seasonal. It would seem reasonable to conclude that fractures which develop in service in the lead sheath near the poles are due to fatigue under the action of repeated stresses.

In prolonged tension tests of specimens from sheaths, at a stress of 1,350 lb. per sq.in., the lead stretched continuously and fracture occurred after over 800 hr. with a total elongation (36 per cent) about the same as obtained in a standard tension test specimen where the load is rapidly applied, but without the necking down of the material that is characteristic of a standard tension test.

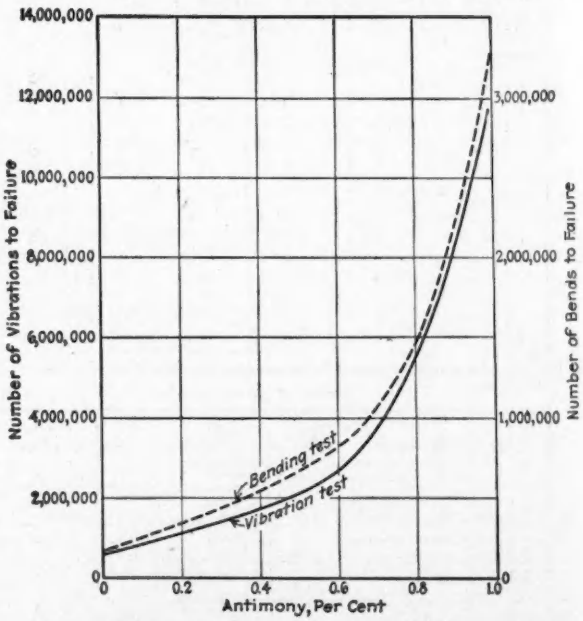


FIG. 1—VIBRATION AND REPEATED-BENDING TESTS OF FULL-SIZED CABLES

To investigate fatigue resistance two types of testing machine were developed for full-sized pieces of cable and a third machine for flat specimens of metal from the sheaths. In one machine a 40-in. length of cable was clamped at one end and the other end vibrated transversely about ⅛ in. In another machine a 9-ft. length of cable bent into the form of a U with 18-in. radius had one end clamped and the other end moved 2 in. back and forth by a movable head. The failure of the sheath was detected in both types of machine by sealing the ends of the cable, and maintaining a slight vacuum in the interior; a mercury manometer connected to the cable registered failure through an electrical connection when fracture of the sheath permitted air to enter and destroy the vacuum. Test results with these two machines are sum-

marized in Fig. 1, in which is plotted number of vibrations required to cause failure, for varying antimony content of the sheaths.

Tests on cable-sheath metal were made on specimens $\frac{3}{4}$x$\frac{1}{8}$

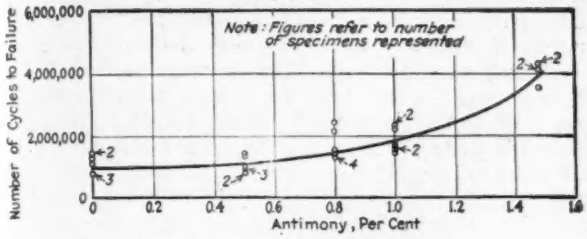


Fig. 2—Effect of Antimony Content

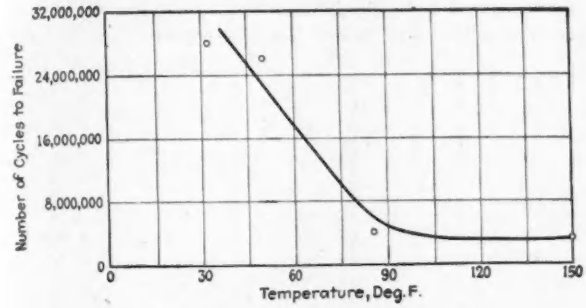


Fig. 3—Effect of Temperature

FIGS. 2 AND 3—REPEATED-STRESS TESTS ON FLAT SPECIMENS

in., 5$\frac{3}{4}$ in. long, cut from wider tape of the metal extruded under conditions identical with average commercial extrusion conditions. The specimen was clamped at one end, on a length of 2 in.; it had a tapered section beyond this point so designed that a length of $\frac{1}{4}$ in. of the specimen was uniformly stressed by the deflection back and forth of the free end of the specimen. Fifty-six such specimens could be tested simultaneously in one machine. The throw of the free end could be varied by means of a variable-throw cam, and was kept below the point of plastic action. The cam speed was 700 r.p.m. and the commonly used deflection was 0.11 in. in the effective bending length of 3 in., corresponding to a calculated stress of 1,350 lb. per sq.in. The results are plotted in Fig. 2, in terms of number of cycles to failure, for varying antimony content, and in Fig. 3 for different temperatures.

All the fractures were found by microscopic study to be intergranular.

Evidence of the similarity of service failures with laboratory failures was found in the appearance of the fractures, showing very evident widening of the grain boundaries, progressing from the central or neutral axis toward the outside of the test specimen. This observation shows that stress is largely responsible for the widened condition of the grain boundaries, which indicate the change in the solid solubility of antimony in lead, a phenomenon first pointed out for this alloy by F. F. Lucas.

* * *

Corrosion-Fatigue of Duralumin

By R. R. Moore
Chief, Physical Testing Branch, U. S. Air Corps, McCook Field, Dayton, Ohio

THE AUTHOR made fatigue tests in a special type of rotating-beam machine using thin-wall tubes instead of sheets. A short inexpensive specimen was used ($\frac{3}{4}$-in. diameter, 0.035 in. in wall thickness, 3$\frac{7}{8}$ in. long). The chemical analysis of the duralumin is: Cu 4.26, Mg 0.55, Fe 0.23, Si 0.21, Mn 0.49, Al by difference 94.26 per cent.

Corrosion of the specimens was accomplished by two methods. One set of specimens was submitted to a 20 per cent salt spray for a five-day period, the spray operating 8 hr. per day, and another set for a ten-day period during which the spray was operated continuously for the first two days, 8 hr. a day for the next six days, and continuously for the last two days.

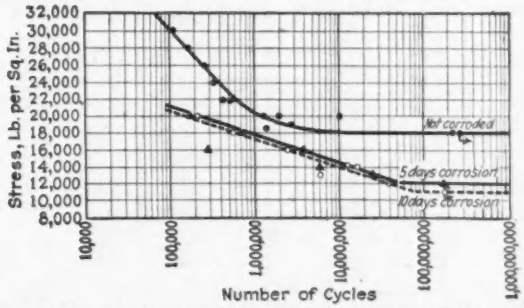
The diagram herewith gives the endurance curves. En-

RESULTS OF STATIC AND FATIGUE TESTS ON THIN DURALUMIN

	Duralumin Tube	Duralumin Tube Corroded, 5 Days	Duralumin Tube Corroded, 10 Days
Outside diameter, in.	0.344	0.344	0.344
Inside diameter, in.	0.304	0.304	0.304
Proportional limit, lb. per sq.in.	40.635	39.410	39.410
Tensile strength, lb. per sq.in.	69.400	67.050	67.930
Elongation in 2 in., per cent	16.8	12.4	12.5
Endurance limit, lb. per sq.in.	18.000	12.000	11.000
Ratio, endurance limit to tensile strength	0.26	0.18	0.16

durance and tensile strength figures are given in the table, all figures except endurance limits being the average of three tests.

Proportional limit and tensile strength are unaffected by the corrosion, but ductility is affected considerably (a loss of 25 per cent). The five- and ten-day periods show practically the same effect. The endurance limit was decreased about 35 per cent by the corrosion, to a minimum of 11,000 lb. per sq.in. It is not to be concluded that this is the minimum ever to be expected in service; it is highly probable that if



ORDINARY AND CORROSION FATIGUE OF DURALUMIN

the corrosion is allowed to progress as the metal is being repeatedly stressed (a practical service condition), the effect of the progressive corrosion will be more severe.

Attention is directed to the fact that the static tensile strength is unaffected by the corrosion, whereas the resistance to repeated stresses is considerably affected. The repeated stress or fatigue test is evidently considerably more sensitive to certain factors than is the ordinary tension test, and for that reason is a more valuable test in determining the serviceability of the metal.

Snow Runoff in Nevada

Good water supply conditions for irrigation, power and other purposes in Nevada this season were predicted on the basis of the seasonal snow survey conducted by J. E. Church, Jr., director of the Nevada Co-operative Snow Surveys. For the Central Sierra, the heavy precipitation of April assured a large runoff. Lake Tahoe was expected to reach a maximum of El. 6226.84, which should suffice for irrigation and power this season, unless there is an extremely dry fall. There would be ample water to fill the Lahontan, Bridgeport and Topaz reservoirs. These conditions are in pleasant contrast with the last few preceding seasons. For the Humboldt Basin, the snow cover, winter precipitation and amount of snow in March indicated an approximately normal runoff from April to July. With heavy summer rain the runoff may reach 125 per cent of normal, but lack of rain and the heavy draft on the Humboldt may reduce it to a minimum of 75 per cent. The Little Humboldt was expected to have a runoff of 150 per cent of normal.

Worth-While Construction Wrinkles on a Building Job

Organization for Quick Alterations — Pump Excavation—Hoist Safeties—Quick Leveling Device—Mobile Scaffold

By Zara Witkin
Chief Engineer, Herbert M. Baruch Corporation, Los Angeles, Calif.

SEVERAL major alterations during construction of the steel-frame 13-story Mayfair Hotel in Los Angeles, Calif., placed a special burden in organization on the contractor and crowded work toward the last into a continuous 24-hour operation. They called, too, for the invention of several devices for simplifying, speeding up and safeguarding a number of processes, and they seem to have possibilities for general use. In this article a consecutive account of the construction is not undertaken; the special devices are merely explained in an unrelated fashion by sketches and brief descriptions.

Alterations in Plans—After excavation had been begun it was discovered that the ground would not carry the building on the original design of spread footings. A cast-in-place pile foundation of some 1,034 piles from 22 to 26 ft. long was substituted. With the extension and resheeting of the original pit, the redriving of some piles forced up by the rubber-like silt during the driving of adjacent piles and the time required to get the pile driving outfit onto the ground and to do the work, the construction time schedule was advanced 70 days. In

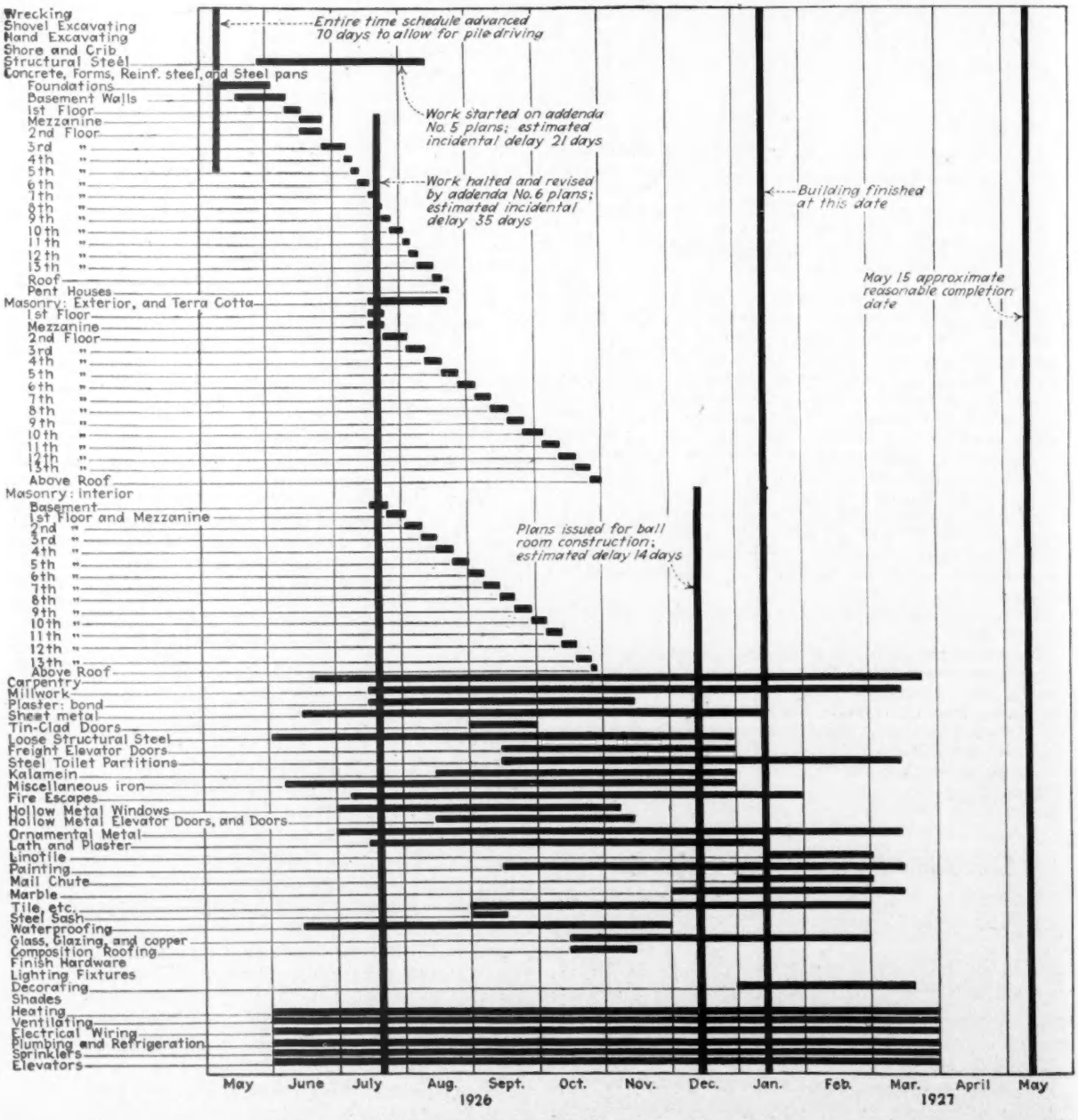


FIG. 1—TIME SCHEDULE SHOWING PLAN ALTERATIONS

this foundation construction stage the first alteration in superstructure plans, causing revision of the construction plan, was announced.

Planned originally as a residence hotel it was found by the owning company that there would be a probable demand for increased banquet room space and other public room facilities. This led to a comprehensive revision of the plans on March 15, but not issued until April 7, 1926, known as Addenda No. 5 (Fig. 1) including modifications of the basement, first floor, and mezzanine floor, and changing nearly every subcontract in the entire list. When the changes involved in Addenda No. 5 had all been estimated and the fair cost arrived at by representatives of the contractor and the architect, the entire situation was again thrown into confusion by another and a more far-reaching change in the plans and specifications of date of June 28, 1926, but issued about July 21, 1926, and known as Addenda No. 6. The entire process of evaluating changes had to be recommenced. Certain changes in schedule were inescapable. The first and mezzanine floor were skipped and the walls and interior of the upper typical floors were begun. Finally in November as the work was nearing completion it was decided by the owners to build a night club on the second floor court area of the building. This involved the demolition of the machinery room already constructed there. By working 24 hours a day in three shifts the entire new job was completed at the same time as the rest of the building. The time schedule chart Fig. 1 indicates these interruptions and brings out a number of facts deserving study.

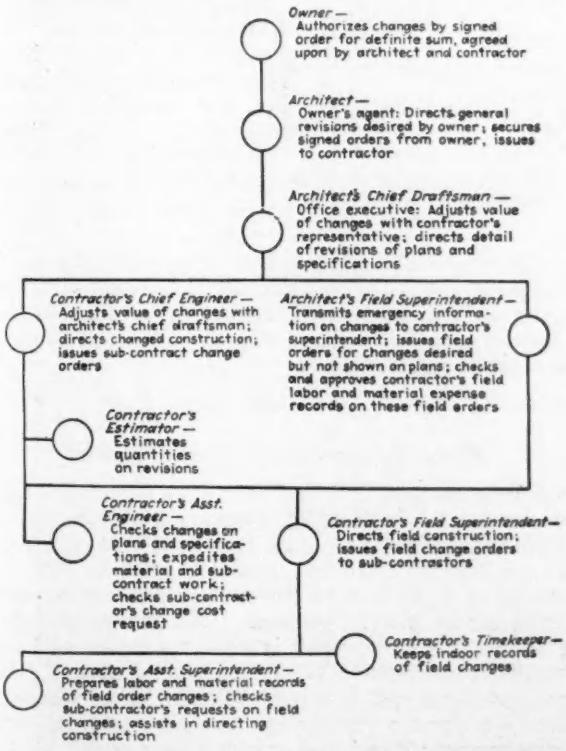

Owner — Authorizes changes by signed order for definite sum, agreed upon by architect and contractor
Architect — Owner's agent: Directs general revisions desired by owner; secures signed orders from owner, issues to contractor
Architect's Chief Draftsman — Office executive: Adjusts value of changes with contractor's representative; directs detail of revisions of plans and specifications
Contractor's Chief Engineer — Adjusts value of changes with architect's chief draftsman; directs changed construction; issues sub-contract change orders
Architect's Field Superintendent — Transmits emergency information on changes to contractor's superintendent; issues field orders for changes desired but not shown on plans; checks and approves contractor's field labor and material expense records on these field orders
Contractor's Estimator — Estimates quantities on revisions
Contractor's Asst. Engineer — Checks changes on plans and specifications; expedites material and sub-contract work; checks sub-contractor's change cost request
Contractor's Field Superintendent — Directs field construction; issues field change orders to sub-contractors
Contractor's Timekeeper — Keeps indoor records of field changes
Contractor's Asst. Superintendent — Prepares labor and material records of field order changes; checks sub-contractor's requests on field changes; assists in directing construction

FIG. 2—ORGANIZATION FOR QUICK ALTERATIONS

Organization to Handle Changes—The terms of the contract required that all additional work, or work arising out of changes in the plans and specifications, be authorized in writing by the owner to the contractor for established and agreed upon amounts, before the contractor commenced this extra work. To abide by this provision and to construct the building under the incidental conditions were together impossible.

The problem of safeguarding the interests of the owner and the contractor with no delay to actual construction gave rise to a special plan of coordination between the architects and the contractor. Each subcontract division of the changed work was evaluated in a sequence determined by its position on the time schedule in connection with related work, and the time required to fabricate, ship and install. As each was approved by the architect and authorized by the owner the general contractor was enabled to authorize subcontract changes, the work being carried on meanwhile. The organization developed by the contractor for carrying out this plan is charted by Fig. 2.

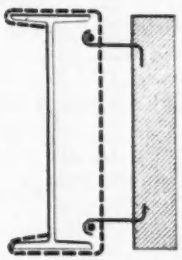


FIG. 3—TILE ANCHOR TO SPANDREL BEAMS

Hydraulic Excavation—An unusual method of digging and transporting material from the elevator pits near the center of the building was used at the completion of the piledriving work and the placing of footings. This material, when wet, had a rubber-like consistency almost impossible to handle with hand-shovels. It was, therefore, decided to do it by hydraulicking. A high-pressure water nozzle was directed at the material and a centrifugal pump, 15-hp. motor, was connected to a 4-in. line of iron pipe leading to the general level of the basement some 16 ft. higher, and on the other side of the building site where certain backfill was required.

The stream of water cut the clay bank and the pump took out the water with the clay in suspension, forcing it through the line of pipe to a point where it was emptied, from which the water seeking the lowest level returned to the elevator pit. This recirculating water thus acted as a vehicle in transporting the clay in suspension. A total of 300 cu.yd. of this material was removed by this method at a cost of $281, or a unit cost of 94c. per cubic yard, which was approximately 100 per cent less than it might have been done by hand-digging and handling.

Anchoring Tile to Steel—The method of anchoring architectural terra cotta facing blocks to spandrel beams of the structural steel frame was one which secured positive anchorage with extreme simplicity. Spaced approximately 2 ft. apart along the structural beams were loops of No. 3 galvanized wire. Held by these loops two ⅜-in. rods ran along the outer face of the spandrel beams near each flange, Fig. 3. To these continuous horizontal rods, which were hooked in at the columns, were attached the terra cotta anchors embedded in the individual blocks. Thus, in-

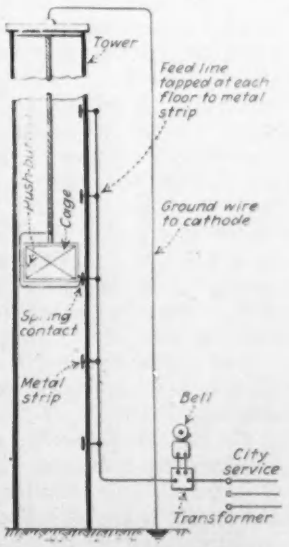


FIG. 4—HOIST CAGE SAFETY SIGNAL SYSTEM

stead of independent ties of each block to its own section of fireproof backing near the structural beam the entire terra cotta load was bound in and made monolithic when the beam was poured with the structural steel frame.

Material Hoist Control—Throughout the conduct of the job every possible means was adopted to render the operations as safe as possible with the result that no major accident occurred during the course of construction in spite of the unusual speed of the work and the many weeks of 24 hour-a-day work.

One of the most dangerous possibilities in the construction of a building is the operation of the material hoist, which should really be considered a freight elevator, and be protected as fully as such apparatus is in a finished building. Ordinarily in construction of this kind the material hoist is operated through a bell signal from the floor at which it is desired to have the car. The hoist man, generally remotely located in the basement, receives this signal and moves the car without certain knowledge that it is no longer in use at the level from which it is moved. There is serious danger that the car is being unloaded or loaded when this signal is given on some other floor. On this building this danger was obviated in the following manner: A button signaling device was placed on the hoist cage itself and not on the frame as is customary. At each floor by a projecting piece of spring metal, contact was made to a lead running to a hoist in the basement. The circuit was grounded through a wire from the tower cathead, Fig. 4. In this manner the signal could only be given to the hoist man from the cage itself. This forced whoever desired to use the car for transporting materials to locate the floor upon which the cage was being used first and to signal from that floor. The slight inconvenience due to this condition was more than balanced by the elimination of all possibility of starting the car when a workman was passing through the opening on a floor where it had been in use, unknown to the operator below.

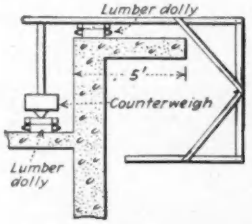


FIG. 5—MOBILE CORNICE SCAFFOLD

Quick Leveling Device—This building being a hotel with numerous pieces of detail work, such as chair rail panel strips on the walls, and electric switches, wainscot tile and such materials, all being required to be placed at identical levels in most of the rooms, the following device was resorted to to avoid expense and inaccuracy in instrument work. Along the main corridors of the building, level marks were placed on the door jambs. A piece of rubber tubing about 30 ft. long with a test tube placed at each end, was filled with water, but leaving a few inches partial vacuum in each tube. One tube was held with its water level on the level mark at the door opening. That at the other end was moved quickly around the walls of the room, in the closets, the bathrooms, and equal levels were marked wherever desired.

Cornice Scaffold—An elaborate sheet metal cornice overhung the structure. The horizontal slab supporting it jutted out 5 ft. from the fire wall. The application of the cornice to this slab, the inspection of the work by the architect, and the decorative treatment required much more flexibility of movement than could be obtained with the usual hooks and swinging scaffold. To meet this special condition a simple counterweighted rolling scaffold was built, as shown in the sketch, Fig. 5, riding on lumber dollys on the roof slab and the top of the fire wall. With this rolling scaffold any spot on the outside of the cornice could be reached by pushing the scaffold along the roof.

Pouring Floor Slabs—Advantage was taken of the L-shaped plan of the building to use a novel and economical adaptation of the chute method of placing concrete in the slabs. The bucket was brought to the level of the second floor above the floor to be poured. Then the concrete was emptied into a floor hopper. From there a chute approximately 40 ft. in length with a swivel mount on the end connected to another chute at a point just below the level of the floor above the one being concreted. This second chute had a 180-deg. sweep and by quick altering of the connection covered the other 180 deg., Fig. 6. The method thus used eliminated nearly all runways and cart-conveying of concrete.

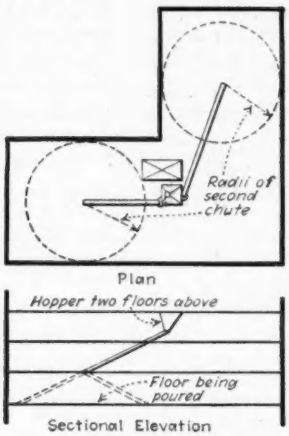


FIG. 6—CHUTE ARRANGEMENT FOR CONCRETING FLOORS

Direction—The building was designed by Curlett & Beelman, architects, and Erick & Deline, structural engineers. The Herbert M. Baruch Corporation of Los Angeles was the builder, with H. Pomfret, superintendent of construction.

Water Regulations in Scotch District

Special charges of £1 per year for a motor car where water is used for washing purposes are made by the Dunfermline District, Fife County, Scotland, according to the London *Surveyor*, June 10, 1927, p. 566. A charge of 1 per cent of the contract price of masonry and brick work and 2 per cent of the contract price for plaster and concrete work is made for water used for building construction. The annual meter rates are 1s. 3d. per 1,000 Imp. gal. for the first Imp. m.g. per year, and 1s. 1½d. for the second Imp. m.g. per year. All consumption over 2 Imp. m.g. is charged for at the rate 1s. per 1,000 Imp. gal. The corresponding rates per 1,000 U. S. gal. are approximately, 25c.; 22½c. and 20c. The minimum annual charge is £2 for 1-in. meters and smaller size, and £4 for larger meters, corresponding to $9.73 and $19.46, respectively. The district supplies and places the meter in a meter house, erected by the consumer. Connections to the main are made by the District, after the consumer has made the necessary openings. The charges for service connections, including corporation, stopcocks and the necessary fittings, together with all future maintenance of them are: for ½-in. connections, £2 10s.; ¾-in. connections, £3; 1-in. connections, £4—corresponding respectively to $12.16, $14.60 and $19.46. For larger sizes special charges are arranged.

Advantages of Water Transport Warrant Special Harbor

Buffington Harbor Built to Handle and Store Bulk Material for Cement Plant on Lake Michigan

ECONOMY in plant service and in the supply of raw material was the main reason for the construction of a new lake harbor at Buffington, Ind., by the Universal Portland Cement Co., adjacent to its large cement mills. Great quantities of calcite limestone are used at the mills and it was considered an economical investment to build this harbor at a cost of about $2,000,000 in order to transport the stone in large bulk shipments by water. A single steamer may deliver 12,000 to 15,000 tons of stone, equivalent to 2,000 or 3,000 carloads of 50 tons. The harbor also enables large shipments of cement to be made by boat, supplementing the rail shipments. Mechanical equipment is provided for unloading and stocking the limestone and for transporting it to the cement plant.

This new harbor, Fig. 1, has a 55-acre basin with a dredged depth of 24 ft. It is enclosed by the stone yard, a rock-filled pier and a rock-mound breakwater, with a riprapped slope at the narrow end. The pier, 15 to 20 ft. wide, consists of two rows of round piles, with a line of wood sheeting back of the piles on the harbor side. Stone filling is capped with rocks weighing 500 to 2,000 lb. A stock yard sufficient for 1,000,000 tons of stone is formed by a sand fill which is enclosed by the dock wall and by pile bulkheads protected from the waves by riprap of massive quarry blocks.

The dock wall, of monolithic concrete, is carried on three rows of 45-ft. piles at 3-ft. spacing, with a line of 40-ft. wood sheeting to retain the fill. Both the piles and the wall are anchored to deadmen buried in the fill and bearing against a row of 30-ft. piles about 32 ft. back from the sheeting. At the rear of the wall are a roadway and a railway track. Instead of having a fixed fender, the face of the wall is protected by two lines of heavy timbers suspended by chains attached to anchors in the top of the wall.

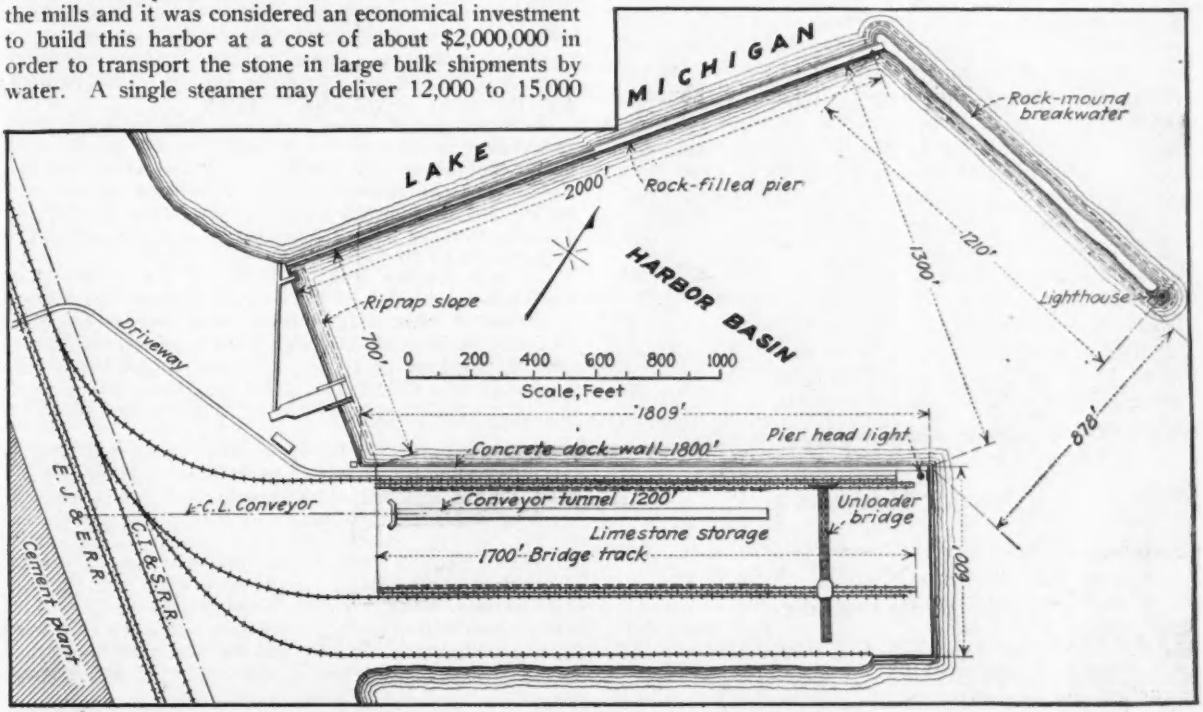


FIG. 1—NEW LAKE HARBOR AT BUFFINGTON, IND.

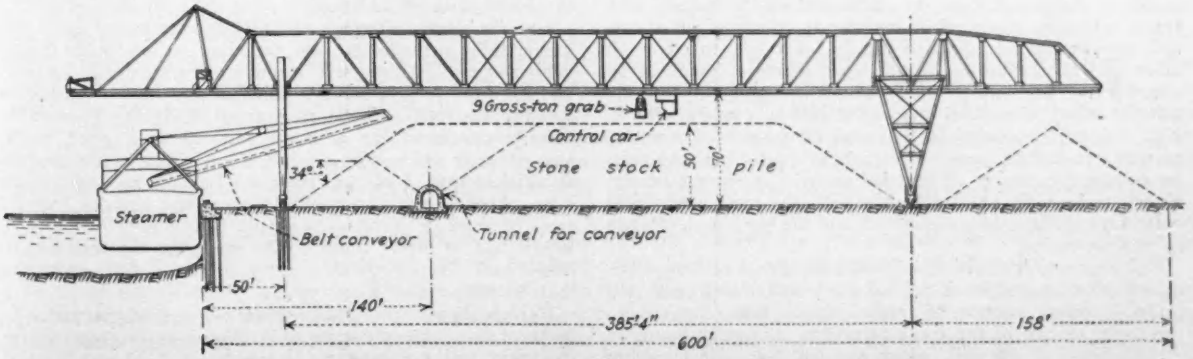


FIG. 2—UNLOADER AND CONVEYOR PLANT FOR HANDLING STONE
A self-unloading steamer is shown diagrammatically. The unloader crane serves ordinary steamers.

Stone is delivered partly by ordinary bulk-freight steamers, which are unloaded by the dock equipment, and partly by special self-unloading steamers which have hopper-bottom holds and conveyor equipment for putting the cargo ashore. Both methods are indicated in Fig. 2. A traveling gantry crane, of the type used extensively at ore and coal docks, provides for unloading the ordinary steamers, for distributing the stone on the stock piles and for reclaiming the stone as needed by the mills. Its grab bucket has a capacity of 9 gross tons, and a headroom of 70 ft. for the crane bridge allows a stock pile 50 ft. high. Two railway tracks extend parallel with the crane tracks.

On the surface of the stock yard is a concrete tunnel about 10x10 ft., 1,200 ft. long, which is normally buried in the stone pile. Traps or gates in the arched roof provide for delivering stone by gravity to the hopper of a traveling feeder which discharges it upon a belt conveyor. As main-line railway tracks separate the stock yard from the cement mill, the conveyor, after leaving the tunnels, rises in an inclined gallery on a steel trestle, and passes over the tracks to the storage bins of the cement plant.

This harbor was designed and built under the direction of A. G. Carlson, chief engineer of the Universal Portland Cement Co., subject to the requirements of the United States government. The Great Lakes Dredge & Dock Co. had the general contract; the Robins Conveying Belt Co. supplied the conveyor equipment, and the Mead-Morrison Manufacturing Co. built the unloading crane. The harbor was opened officially June 9, 1927.

Track Design and Paving for Street Railways

Standard Track Design Impracticable But Only Few Rail Sections Needed—Aspects of the Paving Problem

RAILWAY and municipal engineers have a mutual interest in questions of street railway track construction and the paving of such track, and herewith is given a brief abstract of a paper on this subject presented before the Illinois Society of Engineers by J. I. Catherman, engineer of maintenance-of-way of the Illinois Traction System, which includes some 230 miles of city lines and 550 miles of interurban lines.

Street railway track construction has progressed from the old 40- and 60-lb. T-rail to the 9-in. girder rail weighing as much as 174 lb. per yard. Corresponding features of modern track are treated wood ties protected with metal tie-plates, steel ties, semi-steel or compound ties, rail fillers, welded joints, stone ballast, concrete slabs beneath the ballast, or a track substructure embedded entirely in concrete. A standard specification or standard design for track, to cover all cities and all conditions, would work financial hardship on many properties, and probably would not give the best results to many properties financially able to comply with it. Not only must economy in first cost be considered, but also economy in maintenance. As track will wear out and must be completely rebuilt at certain periods, it should be designed to give the maximum life with the most economical cost, the minimum of maintenance and the maximum salvage in reconstruction.

The first problem which confronts the street railway engineer is that of weight of rolling stock and the present and probable future volume of traffic. Upon these factors depends the design of the track structure. Another factor is the condition of the soil, which has had too little attention and has been responsible for the failure of many stretches of track. A soil which under natural conditions would not support a track structure might be made to support it if proper precautions are used. Stone may be rolled into the subgrade before the ballast is laid, a concrete slab may be installed to support the ballast, or other methods may be carried out. With them all, however, the drainage problem must be considered, and a few dollars spent in drainage of the subgrade or roadbed will return themselves a hundredfold when future maintenance is considered.

The factor of economy in cost confronts the railway engineer continually and requires him to exercise his greatest ingenuity. Too often he stands as a buffer between his management and the municipal authorities, so that he may be put to his wits' end in obtaining a track that will stand up under the traffic to which it will be subjected, will require a minimum of maintenance and will satisfy all those concerned. Local conditions also affect the economy factor. One engineer may require only 8 in. of stone ballast, while another may say 12 in. and a third may require the ties to be encased in a slab of concrete. All may be right, since their local subsoil conditions and the volume of traffic over the tracks govern these features.

My experience indicates that track carrying heavy traffic should have sawed red-oak ties 6x8 in. or 7x8 in., creosoted by the full-cell or empty-cell process, and fitted with tie-plates. For city railway service, the all-steel or semi-steel tie encased in concrete will provide a base of sufficient strength to carry traffic; it is economical, and will last as long at least as the pavement wearing surface.

Our next problem is the rail. One of the greatest blessings that could come to the railway industry would be a committee of railway organizations with courage enough to set forth specifications covering a few types of rails to take care of any kind of traffic, and then manufacturers who would roll these rails and no others. All the requirements of our electric railways could be met by a dozen types of rail.

Track Paving—For the street paving along the track, a few outstanding types are in general use. A concrete pavement can be installed at reasonable cost, but when rails break or joints fail the concrete must be taken up to permit repairs, and no concrete pavement can be patched satisfactorily, especially along a street railway track. When rehabilitation is necessary, there is no salvage from the concrete paving. Brick, wood-block and granite block are three other types of paving in general use. The first and third types are the most efficient, and the use of either one is governed to a great extent by the locality or the convenience with which the material is obtainable.

Wood-block has found a wide and extensive use, but it has also shown the greatest number of failures of the three types. Exposed to the heat of the sun and other extreme weather conditions, the lighter oils will evaporate after a few years and then the block is ready to take up moisture, which is usually accompanied by disastrous results. Many of these failures could be avoided and the pavement given an additional lease of life if after about five or six years' service the surface was given a good spraying of creosote oil or a covering of paving pitch. This would keep the blocks and the spaces between them filled with oil, thus preventing the infiltration of moisture.

Granite blocks, although probably the most expensive, will undoubtedly provide the best wearing surface under heavy vehicular traffic; they will stand up longer along the rails and have the largest salvage value of any type of paving in general use today. Next to granite block, the most satisfactory pavement for a street railway is a good, hard-burned shale brick with asphalt filler. This brick need be no thicker than 3 in. and the sand cushion no deeper than ¾ in. Asphalt has been used to some extent, but one or more rows of brick or stone block should be laid next to the rails. When laid in direct contact with the rails, the tendency to heave and disintegrate is greater in the asphalt pavement than in almost any other type.

Responsibility for Paving—How far should the responsibility of the railway extend with respect to the costs of installation and maintenance of pavement? Payment annually of large sums for new paving and maintenance of old secures nothing of value to the railway. A survey made

by the federal government showed that the electric railways paid out about 10 per cent of their gross operating revenue in taxes, 3.5 per cent of which was a paving tax. This amounts to some $30,000,000 annually. But the car rider pays the bill, in the form of increased fare or increased taxes.

Floor Fire Wrecks Iron Bridge at Danville

Fire Starts During Pavement Repair—Four of Six Spans Destroyed—First Falls in Twenty Minutes

By George C. Stone
Civil Engineer, Danville, Va.

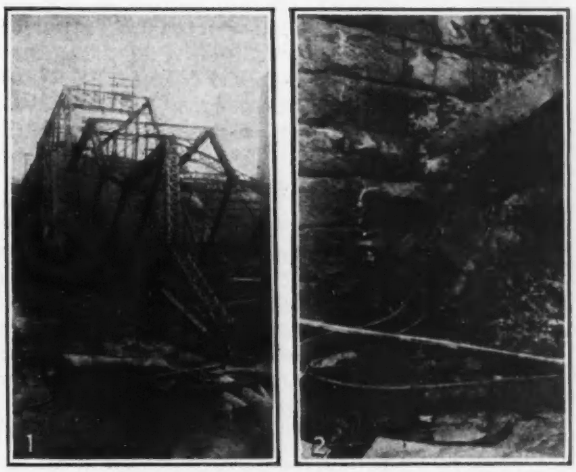
FIRE destroyed four of the six spans of the old "Iron Bridge" across the Dan River at Danville, Va., on June 30. The two sections of Danville will be without trolley connection for several months, and both vehicular and pedestrian traffic will suffer serious inconvenience. The bridge was designed by Theodore Cooper and was built by the Edge Moor Iron Co. in 1887. C. A. Ballou was city engineer of Danville at that time.

The bridge consisted of six spans of 136 ft. 9 in. of pin-connected through Pratt type, with trusses spaced 25 ft. on centers, with 24-in. plate-girder floorbeams and 3x14-in. timber stringers spanning the 17-ft. panels. The floor was built of 4-in. square-edge plank, covered by a layer of waterproofing felt, carrying 3-in. wood block set on end in tar. The stringers, plank and block were creosoted. The bridge carried a 5-ft. walk on each side, outside of the trusses, floored with 2-in. untreated plank laid diagonally over wood stringers.

Originally built by private parties as a toll bridge, it was later bought by the city and made free. In the course of time the load on the bridge had increased until, just previous to its destruction, it was carrying a trolley track, a gas main, two pneumatic conveyor trunks and a heavy burden of electric transmission, telephone and telegraph wires and cables; these were in addition to the vehicular load of automobiles and motor trucks and an extremely heavy pedestrian traffic at certain hours of the day. The flooring itself was considerably heavier than that of the original bridge design.

On June 28 the bridge was closed to vehicular traffic for the repair of the roadway paving and trolley track. Taking up and replacing of the block paving was being done by the city paving department. Work began at the north end, and at 8 a.m. of June 30 the tar kettle was on span 4, the third from the north end. It had some tar in it, was fired up, and several barrels of tar were nearby, ready for use. These barrels had been brought to the bridge from storage the evening before, after a very hot day (99 deg. F., a record for the season). Laborers proceeded to open a barrel of the tar as it lay on the end of a truck ready to pour into the kettle. This particular barrel happened to be an old one (but a tight one) that had been on hand in storage for some time. According to the city engineer's account, they stove in the head of the barrel in the usual way, and immediately the material seemed to explode, as if due to the sudden release of pressure from volatile matter in the barrel. The liquid was thrown by the explosion in every direction, becoming ignited probably from the heated surface of the kettle or from the fire in the furnace itself. The blazing material spread rapidly over the paving and ran down through the crack beside the hub-guard, thus igniting the flooring and stringers, which burned fiercely both top and bottom in the light breeze.

The fire alarm brought prompt response from the fire department, equipment from both sides of the river uniting their efforts and fighting from above and below, but water seemed only to spread the flames, and available chemicals were not sufficient to blanket such an extensive blaze. Within twenty minutes the span on which the fire started collapsed, followed a few moments later by the next span north and then in succession by the two adjoining to the south. By 10 a.m. the fire was under control, and in a short time afterward was extinguished



DANVILLE BRIDGE WRECKED BY FIRE

Left view, looking north. End span standing, next span south collapsed. The fresh sand on the new paving of the latter span helped to check the fire so that it could be brought under control before reaching the north end span. Right view, an end post buckled and doubled back near the floor line, and pulled off its pier when the span fell.

except for the woodwork on the bed of the river which was allowed to burn out. At one time it seemed as if the south span would have to be dynamited to prevent the fire approaching some mill buildings, but a change of wind made this unnecessary.

When the smoke cleared away the four intermediate spans were in the river while the shore span at each end of the bridge stood practically unhurt. The tar kettle was found standing upright on its four wheels, little the worse for wear, on a small island directly beneath where it had stood when the fire started.

An examination of the structural members as they now lie on the river bed in 2 ft. of water indicates that failure of the truss in each case was brought about by the softening and buckling of a compression member at or about the floor level. In most cases the first failure seems to have occurred in an intermediate post (two 8-in. channels laced) but in one span probably in a batter post. No elongated or necked eyebars appear, and there is not a broken eyebar in sight. Collapse of each span was gradual, the trusses careening toward the side first giving way. Many of the top chord members came through practically intact, most of the joints at panel points opening by shearing of the rivets or by actual breaking of the top flange splice plates.

The tops of some of the piers were badly scaled and broken by the heat as well as by the wrenching off of the anchored shoes. The protruding rocks in the bed of the stream beneath the fallen spans were disintegrated by the heat.

Irrigation Is Chief Topic of Am. So. C. E.

City Planning, Highway, Irrigation and Surveying Divisions Hold Sessions—Water Value and Interstate Compacts—Denver's Park System—Highway Contractor's Qualifications

THE meeting of the American Society of Civil Engineers in Denver, July 12 to 16, was favored by a well-balanced program and a good attendance —over 350. Wednesday and Thursday were mainly filled with business and technical meetings. Friday and Saturday were spent at Colorado Springs, as a starting point for various excursions, the outstanding features of the convention. Aside from auto drives to the mountain parks near Denver, including Echo Lake (at El. 10,818), there were trips to the Garden of the Gods, the Cave of the Winds, Cheyenne Canyon, and Pike's Peak (El. 14,109).

Local Sections

A local sections conference was held on Tuesday prior to the formal opening of the convention. Representatives of about thirty local sections met here to exchange ideas on programs, committee organization, extending acquaintance among members, employment service, membership qualifications, and professional conduct. The latter subjects were treated more as national than as local problems. The committee on local sections is preparing a report that will present comprehensive information on each section.

On Wednesday morning President John F. Stevens delivered the annual address. He touched on historical events leading up to the construction of the Panama Canal and reviewed his connection with the work.

In the business session it was voted to refer to letter ballot of the membership constitutional amendments which would put on a more equitable basis the admission requirements as to age, amount of technical training and practical experience.

Separate meetings were held by four technical divisions namely, (1) Irrigation, (2) Surveying and Mapping, (3) Highways and (4) City Planning. The program was arranged so that not more than three division meetings were in session simultaneously, and this number only on Thursday morning.

Irrigation Division

In the irrigation division, which had a long program, there was little time for general discussion. However, the subject of water right appraisal brought out interesting differences of opinion. One speaker cited five different methods that might be used as a basis of valuation of rights to water.

Joseph Jacobs (Seattle) pointed out how much easier it is to prove that water rights have a value than to show just what that value is. He drew a distinction between the value of water required for a certain definite purpose and the value of stored water offered for sale. F. H. Tibbetts (San Francisco) said that while the value of water rights is generally admitted, there is no literature and a lack of precedent. In a recent lawsuit water prices cited varied from $1,272 to $70,000 per sec.-ft. H. W. Dennis (Southern California Edison Co., Los Angeles) drew attention to the Owens Valley situation, where severance damage appears to have become a factor in water values. Claims there are based on the depreciated value of business property, which has of itself no rights to or direct benefit from a water supply. R. L. Parshall (U. S. Department of Agriculture, Fort Collins, Colo.) cited recent sales of stored water in Arkansas valley at $2 to $4 per acre-foot.

On the subject of "Transmission and Delivery of Reservoir Water" G. Clyde Baldwin (deputy commissioner of reclamation, state of Idaho) cited experience on the Snake River incidental to transmitting water 200 to 300 miles from the point of storage. Because of the channel losses in such transmission, the value of water should be rated at some stipulated point.

In a paper on "Administration of Stream Flow," Edward Hyatt, Jr. (chief, division of water rights, state of California) referred to the fourteen water codes in use in the western states and stressed the differences between riparian and appropriation factions. The riparian rights doctrine as now in effect in California has been a great handicap to equitable water administration. In the Kings River controversy more than two hundred lawsuits have been filed and some forty decrees entered, the matter finally becoming so complicated that operation was feasible only under a mutual agreement.

M. C. Hinderlider (state engineer, Denver) reported that studies of seepage and other channel losses in transmitting water show the rate to vary widely from day to day, and to be affected by a number of factors. In the administration of Colorado waters, stress is laid on four points: headgate design, measuring devices, recording devices, and administrative personnel—the last being particularly important.

E. B. Debler (Bureau of Reclamation, Denver) said some of the old Spanish land grants specifically attached riparian rights to the grant, and these rights may be factors in present rights.

Reporting for the committee on Duty of Water, S. T. Harding (Berkeley) said that the committee is finishing up three years of work and expects to report this fall. The committee on Co-operation between Federal and State Agencies finds much work yet to be done, witness the fact that in developing a project recently undertaken the engineer had to deal with fifty bureaus, commissions, etc. F. C. Scobey (U. S. Department of Agriculture, Berkeley) suggested that the irrigation and power divisions deal jointly with this subject, in the interests of more rapid progress.

The committee on Interstate Waters has mapped out a program of work to be done, chiefly with relation to proposed, pending or executed compacts between states. On motion of this committee, the division adopted a resolution which favors adjustment of interstate water problems by agreements between the states and the federal government and urges that the proper state agencies at the earliest possible date take the initiative toward nego-

tiating such agreements on the lines best fittted to the individual streams.

No report was received from the committee on a national reclamation policy; a report was requested in time for the October meeting.

City Planning Division

In the city planning division park and city plan development in Denver and street design were the two starting points for discussion. Charles D. Vail (department of improvements and parks, Denver) described the city's 10,240-acre mountain park system. The enterprise has decided value in enlarging the tourist crop and is supported by a tax of from ¼ to ½ mill. The extensive highway system permits the citizen in two hours to attain an elevation of 10,249 ft. above sea level, at Echo Lake, within easy reach of perpetual snow. Other recreational features also are extraordinarily developed and supported, and money is even being supplied to the support of private recreational efforts.

Fred W. Ameter (Denver) spoke of rear yards and rear loading space requirements of the Denver code and also of the set-back regulations in local business zones, placing the sidewalk on private property and allowing customers' parking out of the way of fluid traffic. J. Haslett Bell (Denver) in a talk on street embellishment, urged the routing of heavy traffic ways by or adjacent to parks, better design of street lamp standards, trolley poles and street signs, and purchase of small parcels of land at street intersections, which might otherwise be used for undesirable commercial purposes. Encroachments also should be watched.

A paper on "Planning of Capital Cities with Special Reference to Denver" was read by S. R. DeBoer (technical adviser, Denver city planning commission). In discussion Morris Knowles (Pittsburgh) pointed out that the three fundamental considerations in city planning should be the needs of (1) home, (2) business and (3) recreation, and no city plan is complete which does not properly meet the requirements of all three. R. R. Lyman (Salt Lake City) referred to the 132-ft. width of Salt Lake streets. Mr. DeBoer pointed out that even with this width, because of the length of the squares (660 ft.), Salt Lake City actually has less street area than Denver.

I. J. McCrary (Denver) spoke on plans of street layout to permit bypassing traffic from the Union Station around the retail district to the residence and hotel district; now it must filter through the business section, and thereby increases congestion. Certain 48-ft. roadways are to be widened for 6-lane traffic.

"Street Design for Various Uses," by G. W. Tillson (La Grange, Ill.), outlined functions of a street: to facilitate traffic, to furnish light and air to adjacent buildings, to furnish opportunities for the construction of public utilities, and to add to the beauty of the municipality. W. W. DeBerard (Chicago) elaborated on the effect of business areas on street widths and location. The Chicago Regional Planning Association has measured retail business frontage in 28 cities of the Chicago District and found 50 ft. is the average frontage per 100 persons. Since business streets should be wider than residence streets, these figures have direct bearing on city-planning layouts, and also can serve to back up the position of zoning boards of appeal when asked to add more business area; most cities already have a large factor of competition. Fluid traffic lanes of 10 ft. and parallel parking widths of 8 ft. have been adopted as standard unit widths from which to make up pavement widths. Allocation of certain space for underground conduits for water, sewer, gas, electricity and telephone ducts are embodied in a conduit code for Chicago suburban areas. The code contains numerous requirements and is not a specification but can be used as the basis for city ordinance regulations. Harold Lewis (New York) noted the great need for more attention to highway grade separations as a safety measure and to increase speed and capacity.

Surveying Division

In the surveying and mapping division Charles W. Henderson, engineer, U. S. Bureau of Mines, pointed out the necessity for large scale base maps for ore finding and stated that a good topographic map is equivalent to 70 per cent of the geologist's work. He said that there is ample justification for the difference in unit cost between $85 per square mile for a map of 2,000 ft. to the inch and $165 for a map of 1,000 ft. to the inch. Max W. Ball (Argo Oil Co., Denver) in discussing the use of topographic maps in oil operations, stressed the scarcity of good topographic maps. He argued that topography should be tied in to section lines and existing monuments, and the map should be 1 in. to 1 mile for general work and 2 in. to 1 mile for detail work.

Highway Division

At the highway division meeting a paper on "Qualifications of Contractors" by Frank T. Sheets (chief highway engineer, Illinois) recommended the use by engineers and public officials of financial, experience and equipment questionnaires to determine the bidder's qualifications. Inexperience, lack of funds and inadequate equipment were given as the main causes of contractor failures. On paving and bridge work, net quick assets of 20 per cent of contract price should be looked for. Col. Ralph F. Proctor (chief engineer, Maryland Casualty Co., Baltimore) stated that loss on contracts often results even where general qualifications from information available are satisfactory. In the majority of defaulted contracts the contractors were, upon the facts presented, entitled at the time to the bond given.

Morris Knowles (Pittsburgh) stressed the obligation of the engineer under many contracts to supervise construction regardless of the qualifications of the contractor. He suggested a contract clause authorizing the engineer to investigate contractors' qualifications before bids are opened. From a certified list so prepared, the letting authority should then select the successful bidder.

Foundation Grouting at Camarasa Dam

Deep foundation grouting is in progress at Camarasa dam, near Barcelona, Spain. This 300-ft. structure, the highest dam in Europe, rests on fissured rock containing solution cavities down to a considerable depth. The François Cementation Co. of Doncaster, England, has taken a contract for sealing the rock by grouting. It is expected that the work will be done to a depth of 400 or 500 ft. below the base of the dam; probably a combination of filling with inert material, cement grouting and asphalt grouting will be used. Grout holes are being drilled through the dam from the top.

Skew Arch Reactions Measured by Reciprocal Method

Influence Contours Determined by Ingenious Tests on Hard-Rubber Model of 30-Degree Fixed-End Arch

EXPERIMENTAL studies to determine how the reactions are distributed along the abutments of skew arches were carried out two to three years ago by the Bureau of Public Roads by the process of directly loading small-sized reinforced-concrete arches and weighing the reactions by means of weighing scales. These experiments were made on arches of 7-ft. span (measured along the arch face), width 4½ ft. (measured along the abutment), and rise 1.4 ft. The results showed a high concentration of reaction and thrust near the obtuse angle of the arch, but beyond this general result they were rather inconclusive.

During the past year the same problem was attacked by a radically different method in the laboratory of Prof. George E. Beggs at Princeton University, with the result of producing detailed data on abutment reactions for a 30-deg. skew arch of the same proportions as that tested at the Bureau of Public Roads. Professor Beggs presented the data at the last annual meeting of the American Society of Civil Engineers. They are reproduced in the six diagrams grouped in Fig. 1 herewith.

The measurements were made by a highly ingenious application of the reciprocal principle. According to this principle the relation between a load and a reaction is the inverse of the relation between the movement of the arch and the abutment at the two points in question, the arch first being made free at the point where the desired reaction is to be measured. In order to apply this method, Professor Beggs used as test object a hard-rubber model of the arch. After many difficulties he succeeded, with the help of the research department of the U. S. Rubber Co., in obtaining such a model of satisfactory quality and uniformity, one-fourth the size of the corresponding arch in the series tested by the Bureau of Public Roads. It has the following dimensions: span 21 in. on the face of the arch, width 13½ in. along the abutment, rise, 4.4 in.

A view of the test set-up is given by the photograph, Fig. 2. On a very heavy base of deep I-beams there were mounted two angle clamps, so placed as to receive the extended abutment ends of the model arch; one of them was attached to a plate fixed to the base, the other on a plate free to move with respect to the base and restrained from such motion only by six screw-jack struts, three of which may be seen in the photograph while three are below the movable (left-hand) abutment plate. These six struts were so placed as to resist, respectively, the end thrust, side thrust and vertical load of the abutment, and the three corresponding rotational tendencies of the same abutment. Correspondingly, by screwing in or out on one of the jack struts, the abutment could be shifted a slight amount in the direction of any one of the reactions, or rotated a definite amount in the direction of one of the reaction moments.

To measure the vertical movements of the arch, a large number of vertical gage rods was provided. Except for those which were arranged to measure the abutment displacements, these rods were set by their sharp-pointed lower ends in gage-point indentations on the arch extrados, and extended thence vertically upward through a guide plate to an equal number of dial gages, one placed in contact with the upper end of each rod. These dial gages are clearly seen in the view, as are also three horizontal gages and three vertical gages at the abutment, placed to measure the abutment displacement.

The tests were made by giving the movable abutment a small motion, either vertically (in the direction of the load reaction) outward or laterally, or rotational in the direction of one of the three reaction moments; then, the gage dials having been read before the movement of the abutment, they were again read after the

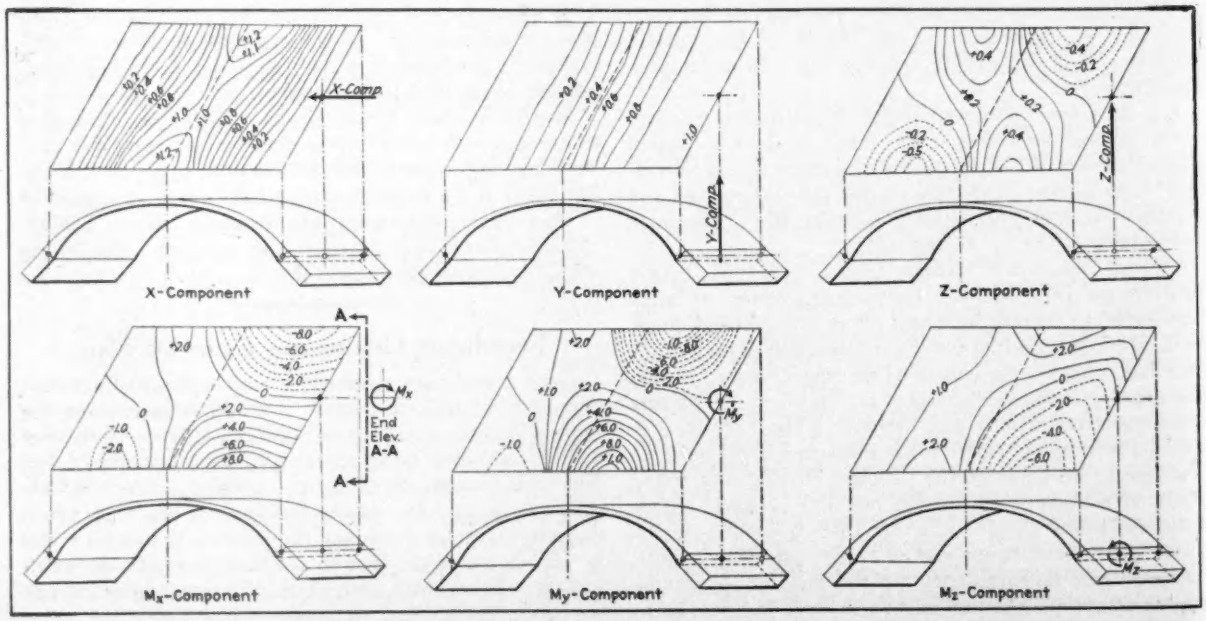


FIG. 1—REACTION, THRUST AND MOMENT INFLUENCE CONTOURS FOR 30-DEGREE SKEW ARCH

movement. The ratio of the abutment movement to the arch dial movement gave at once the ratio between an arch load on the point corresponding to that dial and the abutment reaction which that load would produce if the abutment were held rigid.

By a complete series of such readings for each of the six abutment movements corresponding to the reactions and moments, data were secured from which influence contours were plotted, precisely as topographical contours are plotted from a series of elevation readings. These contours are reproduced in Fig. 1.

In addition to the direct practical value of these influence contours for skew-arch calculations, their interesting feature is the lack of symmetry in the moment curves and the curves for lateral thrust (Z-component), and the occurrence of isolated high-thrust areas near either end of the crown in the curves for outward thrust (X-component).

How far the form of the influence contours is affected by ratio of width to span of arch, as well as by degree of skew, is not yet known. To investigate these points, Professor Beggs plans to continue his tests, first by cutting the original model to successively narrower widths and repeating the measurement, and later by testing similar models of other degrees of skew.

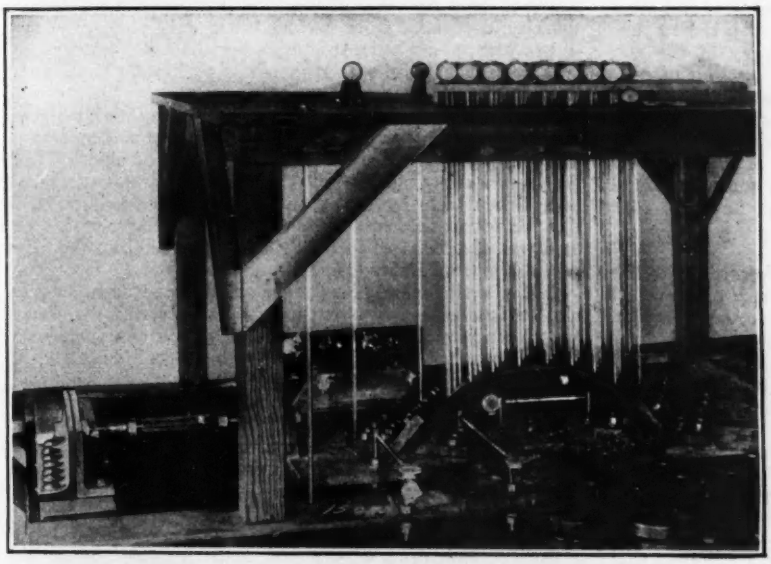


FIG. 2—HARD-RUBBER ARCH OF 21 IN. SPAN, UNDER TEST

Professor Beggs' experimental work was part of the work of the research committee on concrete and reinforced concrete arches of the American Society of Civil Engineers. The primary purpose of the model tests was to establish a standard by which various theories of skew-arch action may be checked. Prof. Charles Rathbun of the South Dakota State School of Mines, Rapid City, S. D., has developed a theory of skew-arch action which yields influence contours agreeing remarkably well with those determined by the experiment on the 30-deg. skew arch. If equally good check is found in the experiment on skew arches of other widths, and other degrees of skew, his theory may be approved as closely correct for practical use. Practical skew-arch design will necessarily be dependent upon a suitable method of analysis rather than directly on stress determination through the use of models.

Sewage Pumping Plant at Santa Monica

THE trunk sewer to be built to serve Santa Monica, Calif., under agreement with Los Angeles (see *Engineering News-Record*, Jan. 13, 1927, p. 93), will be on a grade such that 75 per cent of Santa Monica's sewage will flow into it by gravity. The other 25 per cent will be pumped into the trunk sewer from a new sewage pumping plant built at a cost of $50,000 in a corner of a city park on the beach at Santa Monica. This plant is underground, adjoining the pumping and screening plant recently abandoned. Over this new pumping plant is a comfort station and a bank of transformers serving pump motors.

Santa Monica's present sewage flow, from a population of 45,000, averages 4 sec.-ft., and in 1925 city authorities decided to put in new equipment to take care of a flow of 15 sec.-ft. The joint trunk sewer through Santa Monica to the Venice district will have a capacity of 20 sec.-ft. of which 15 will serve Santa Monica and 5 will be available for later use of the North Palisades tract adjoining Santa Monica to the north which is part of the city of Los Angeles; the tract drains through Santa Monica.

The new pumping plant in Santa Monica consists primarily of two 1,400-g.p.m. vertical centrifugal pumps driven by 30-hp. motors. Space for an additional pumping unit is provided, but the two units are expected to be able to handle an ultimate flow of 6 sec.-ft. under the maximum head of about 42 ft. Such part of Santa Monica sewage as goes through this plant will be lifted twice en route to the Los Angeles north outfall sewer, the lift from the Venice plant being about 35 ft.

The pumping units in the Santa Monica plant are located in a concrete-lined pit, 13 x 31 ft., 28 ft. deep. Adjoining this pump pit is a 90,000-gal. sewage storing tank, concrete-lined, 31 ft. square and 26 ft. deep. This will be the point of delivery of the city sewers tributary to the pumping station by gravity and the sump from which the pumps will be supplied. There is also a storage tank at the shore end of the municipal pier. These two tanks plus the 30-in. line connecting them will have capacity to store the city's sewage flow for a period of 24 hr. The city's present outfall for the disposal of screened sewage follows the municipal pier to a point 1,600 ft. from the shore line. This outfall will be retained for use in case of any interruption in the delivery to Los Angeles north outfall sewer.

The storage tank at the pumping plant will be cleaned by the pressure jet method. A 2-in. pipe perforated with small holes at intervals of 1 ft. has been laid around the top of this tank and when it is emptied for cleaning, water jets under a pressure of 125 lb. per. sq.in. will be directed downward against the side walls of the tank to clean off any adhering deposits.

Installation of the new sewage disposal works has been under the general direction of Howard B. Carter, city engineer of Santa Monica.

U. S. Public Health Service on Montreal Typhoid

Epidemic Attributed to Milk Infected at Point of Production and Much of It Probably Bypassed at Pasteurizers—Local Health Officer Still Lacks Means to Safeguard Milk and Control Typhoid

Report of Surgeons L. L. Lumsden (Chairman), J. P. Leake and C. E. Waller (Recorder) and Sanitary Engineer C. R. Crohurst

THE board of officers convened under Bureau order of June 16, 1927, for the purpose of surveying the typhoid fever situation in Montreal, Canada, and the vicinity thereof, with a special view to the determination of measures needed to prevent the spread of the infection from that city and vicinity into the United States, has the honor to report:

Our survey was begun June 18, and was terminated June 29. Upon arrival at Montreal on the morning of June 18, we conferred with the Consul in Charge of the U. S. Consulate and with officials of the city, provincial and federal health departments. Our studies included (1) examination of the typhoid fever records of the city of Montreal and other parts of the Province of Quebec for the period Jan. 1 to June 18, 1927, and for previous years; (2) survey of the city water supply and sewerage system; (3) inspection of milk plants in the city and of milk receiving stations and dairy farms in the surrounding country; (4) collection by personal interview of detailed epidemiological histories of 203 case selected so as to be fairly representative of all the cases occurring in the whole epidemic period; (5) consideration of the adequacy of the locally operating health forces to cope with the situation.

Extent and Features of the Outbreak—According to the official records, there were reported in the city of Montreal for the period March 1 to June 28, inclusive, of this year, 4,755 cases of typhoid fever with 453 deaths as against 37 cases with 11 deaths, 48 cases with 18 deaths, and 44 cases with 21 deaths for the period March 1 to June 30 of 1926, 1925 and 1924, respectively. From the official record of cases and without consideration of the possible number of additional cases unattended by physicians or not diagnosed and reported, it is evident that since March 1, 1927, Montreal has suffered a severe epidemic of typhoid fever with a case incidence in proportion to population probably unprecedented by any other large city in the world within this century.

No evidence was obtained by our survey to suggest that either the city water supply or the city sewerage system operated in the spread of the infection causing the epidemic.

The disease was distributed over the greater part of the area of the city with much more concentration in proportion to population in some sections than in others. The geographical distribution of the cases when considered in connection with the distribution areas of the city water furnished practically conclusive evidence that the city water supply was not infected as delivered from either of the two separate plants, or in its course through the city mains so as to have operated importantly in the spread of the infection causing the epidemic. The distribution of the disease was such, however, as to suggest strongly that the main volume of the infection had been conveyed through some medium, other than water, which reached a large number of persons in different parts of the city at the same time.

Causation of Epidemic—According to the official records furnished us, it was found soon after the beginning of the outbreak that a very large proportion of the cases were in persons who gave a history of drinking milk distributed from the plant of the Montreal Dairy Co., Ltd. The distribution from this plant constituted in the period of causation of the outbreak about one-eighth of the total milk supply of the city. Judging from the epidemiological case histories obtained by the city health department through detailed inquiry at homes of patients and from those obtained by ourselves through usually direct interview with patients or convalescents at private homes, in public institutions and in hospitals, it appears definite that at least six-eighths of the cases in the epidemic were in persons who, in the period of causation, were knowingly exposed to the milk output from the plant of the Montreal Dairy Co., Ltd. We found no evidence that there was any significant disproportion of cases among habitual users of milk from any of the other dairy plants.

The local institutions, such as boarding schools, orphanages, and homes for helpless adults, with a total population of approximately 15,000, furnished a striking contrast. In those institutions whose inmates used milk from the plant of the Montreal Dairy Co., Ltd., the rate of prevalence of typhoid fever was high, while in those whose inmates, though constituting a large majority of the total institution population of the city, used milk from various other milk plants, the rate of prevalence was little, if any, higher than that for the general population in the corresponding periods in the several previous years.

The age distribution of the disease was also highly significant. About 32 per cent of the cases in the epidemic were reported among children under 10 years of age. These points and every other point of evidence obtained by us supported the conclusion that the vast bulk of the infection causing the recent epidemic of typhoid fever in Montreal, Canada, was disseminated in the milk distributed from the plant of the Montreal Dairy Co., Ltd.

Not a single point of evidence to support any other conclusion has become apparent to us. Exactly where and how the infection was introduced into this milk supply has not been determined. In view of the tremendously high rate of prevalence of typhoid fever among the persons who were exposed to this milk in the period between Feb. 15 and May 15, 1927, it is only reasonable to assume that there was at times within this period heavy dosage infection in this milk when it was ingested. Such evidence of dosage suggests that after the infecting matter was introduced into the milk there was sufficient time and suitable temperature to permit a large multiplication of the typhoid bacilli. Otherwise very gross contamination of the milk with infected human excreta would have to be assumed.

The two charts attached hereto indicate respectively the daily report of cases and the dates of onset of the cases. The date of onset as given in Chart II varies considerably in meaning but as a rule means the date which the patient gave as that of the earliest typhoidal symptoms. From these charts it appears that the causation of the epidemic began about Feb. 15, increased rapidly toward its maximum about Feb. 19, reached its maximum about March 5, continued high until March 18 and then rapidly declined so as to be at less than one-fifth of its maximum rate by March 26. From careful study of individual cases it seems that the decline of causation was greater than is suggested by the chart. In fact, it is quite probable that there was a complete cessation of the main current of infection from March 27 to April 20. At about the latter date there was another very sharp rise in the rate of causation. The causation rate of this second outbreak or recrudescence reached its maximum about May 2, began a rapid decline about May 6, and was down to less than one-fifth of its maximum by May 15. The cases reported with onsets subsequent to May 25 have been in decreasing proportion among persons exposed to the milk distributed by the Montreal Dairy Co., Ltd., and in markedly increasing proportion among persons exposed to personal contact with previous cases.

The milk supply distributed by this company was obtained from 1,200 to 1,500 farms. The families on the farms producing milk within the general vicinity of Montreal average large. The farms as a rule are narrow and dwellings along

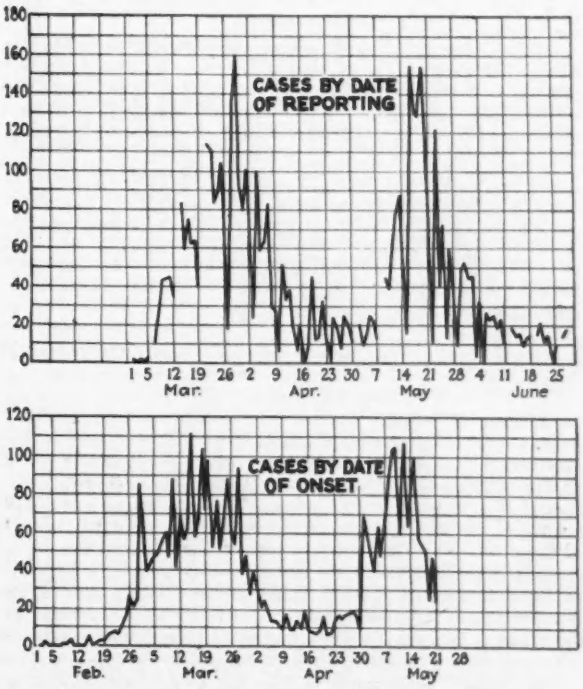
the highways for long stretches are close together. The residents are a sociable people. We estimate that the milk from the farms furnishing the milk distributed by the Montreal Dairy Co., Ltd., was exposed more or less to a population of 20,000. In view of the usual rate of prevalence of typhoid fever in this community it would be unreasonable to assume that there was no typhoid infection among these persons during the period of causation of the city epidemic. Judging from such reports as we received and from quite extensive observations made by us, the average dairy farm in the general vicinity of Montreal presents unsatisfactory sanitary conditions. Open privies and open wells are frequent. In much of the country there is a limestone formation outcropping to or near the surface of the ground. Milk-house doors are in many instances within a few feet of kitchen doors. Surface streams are used quite commonly as sources of water for the milk houses and for the disposal of sewage from homes upstream.

Some of the milk from the farms was conveyed direct to the city plant of the Montreal Dairy Co., Ltd., and some was sent through four receiving stations in the country. At the receiving stations the milk usually was emptied from the farmers' cans, cooled, placed in the company's cans and then conveyed to the city plant. There was certainly a possibility for the introduction of typhoid infection at these receiving stations. At one of them the water used mainly for washing the interior of the milk cooling vats and other equipment was pumped from a nearby river which was obviously polluted with sewage and privy contents at numerous points upstream from and near the intake for the water. The amount of whole milk transmitted through this station was markedly decreased after March 26 and discontinued after May 6.

At the city plant the following routine procedure was reported: The milk upon delivery was weighed, cooled in a surface cooler and passed by gravity to storage tanks where it was held until needed. From the storage tanks it was passed to the clarifier and thence to the open-surface regenerator. From the regenerator it passed to the pasteurizing machine where it was heated to a temperature from 142 to 145 deg. F. and held at that temperature for a period of about 30 minutes. After pasteurization the milk went through the inside of the pipes of the regenerator, then to the surface cooler and then to the bottling machine. Inspections of this plant were made by Assistant Sanitary Engineer F. J. Moss of the U. S. Public Health Service who was detailed to assist the board in its survey. He reports that the pasteurizing machine was of an efficient type, but that as it was probably operated in at least a part of the period of causation of the epidemic there was a possibility for a very small quantity of milk to leak through the valve leading from the pasteurizer before being held at the temperature of 142 deg. F. or more for the full 30 minutes.

The charts of the recording thermometer were examined carefully by Mr. Moss and Mr. Crohurst. The charts indicate that the milk which was run through the pasteurizer within the period of causation of the outbreak was with occasional minor exceptions heated to 142 deg. F. or over and held at that temperature for 30 minutes. Such heating is regarded as sufficient to have killed all typhoid bacilli which may have been in the milk actually so pasteurized. If all the milk which entered the plant direct from the farms or through the receiving stations was freed from whatever typhoid infection it contained by the pasteurization process, the question is where and how the infection could have been introduced into the milk in sufficient volume, or so as to become of sufficient volume, to account for the epidemic. According to all the evidence obtained by us the milk immediately after leaving the pasteurizing machine was kept at a temperature of 40 deg. F. or below until transferred to the delivery wagons, and as a rule the milk was started on the delivery wagons immediately or within a few hours after being bottled or canned for ultimate delivery. If such was the case, the chances for great multiplication of typhoid bacilli introduced into the milk after pasteurization would have been exceedingly remote, and very gross contamination of the pasteurized milk in the plant would have been necessary to account for the tremendous current of infection which went out with the supply of milk distributed from this plant. It appears that slight contamination of the pasteurized milk by finger touch or otherwise by workers in the plant was possible. All the evidence, however, seems to us to make untenable such an explanation of the main current of the infection.

A search was made by the city and the provincial health departments for possible typhoid bacillus-carriers in the plant. One of the employees, the foreman of the plant, was found on April 6 to give a positive Widal blood test. This man gave a history of having had typhoid fever 20 years before when he was 13 years of age. His feces have been examined on 9 occasions and his urine on 7 occasions since April 8 by either the city or the provincial health department laboratory, or both. The urine has been found negative on all examinations. His feces were found positive for *B. Typhosus* on 4 of the examinations. The last two specimens



DAILY NUMBER OF TYPHOID CASES AT MONTREAL
Plotted from Montreal Health Department records.

of feces obtained from him on June 17 and 25 were both found negative for typhoid. This man states that he knows of no attack of typhoid fever among any of his immediate household associates since his attack 20 years ago. He worked for about 7 years at the creamery of the Montreal Dairy Co., Ltd., immediately before entering upon his duties at the milk plant of that company on Feb. 5, 1927. He states that as foreman of the milk plant he seldom touched with his hands the milk either before or after it was pasteurized, but that while engaged at the creamery he frequently had finger contact with both the equipment and the cream. No evidence of a typhoid outbreak traceable to the cream from the creamery while he was engaged there has been presented. This man appears tidy and of very cleanly habits. He was removed from the milk plant on April 16. The time he began duty at the milk plant synchronized with the beginning of the causation period of the epidemic, and this might be considered as possibly suggestive of cause and effect. It is difficult, however, to conceive, if he started the current of infection in the milk, why he ceased to infect the milk during the period from about March 26 to the date upon which he was removed from the plant, April 16. It is entirely unreasonable to suspect that he was a causative factor in the second outbreak or recrudescence which had the peak of its causation about May 2.

The possibility that other persons working in or visiting the plant may have been minor contributory factors in intro-

ducing typhoid infection into the milk may be argued, but all the general epidemiological evidence would definitely oppose any hypothesis upon which to base a conclusion that the main current of the infection was derived from personal touch within the milk plant.

On the other hand, the general epidemiological evidence supports the view that the main current of the infection causing the epidemic was in all probability in the raw milk as it entered the plant and that through advertence or inadvertence on the part of the workers in the plant a large proportion of the raw milk which entered and was distributed from the plant escaped efficient pasteurization, or even a run through the pasteurizer, regularly or at least frequently during the periods February 15 to March 27 and from April 20 to May 15, 1927. From a study of records available to us it appears certain that at times during the period of causation of the epidemic more raw milk was delivered to the plant than was run through the pasteurizer.

Other Possible Factors—The epidemiological case histories and other evidence obtained by us eliminated all factors other than milk which might operate preponderantly in the causation of such an epidemic. The hypothetical factors so eliminated were vegetables, shellfish, "carriers" in public eating places, etc.

The case histories obtained by us do suggest that cream and ice cream distributed by the Montreal Dairy Co., Ltd.—the ice cream having been made at the older plant of the company which was operated in close connection with the milk plant—served as a factor of causation for a small proportion of the cases occurring in the second outbreak or recrudescence.

Adequacy of Local Health Service—When the epidemic began, the city health department was operating on an annual budgetary basis of 40c. per capita. The working force has since been augmented by the employment of four sanitary inspectors. Only one inspector is especially engaged in inspection of pasteurization plants, of which there are 41 or 42 in the city, and he is said to devote a considerable proportion of his time to other duties. The conditions generally found on the dairy farms indicate that the sanitary control of these farms has been and is yet far from adequate.

Only eight health nurses are now engaged in communicable disease control work in Montreal. With over 3,000 typhoid cases or convalescents at homes in the city, and with the usual prevalence of other communicable diseases, the inadequacy of such a small force of nurses is obvious.

Our definite impression is that the city health officer at Montreal has honestly and sincerely recognized his responsibilities during the epidemic and has done his best to render efficient service under most difficult and trying circumstances. It is evident that he should be given ample authority and adequate efficient personnel at once to cope effectively with the present typhoid situation and with other serious preventable disease situations which are likely under existing conditions to develop in Montreal in the future. Such provision is of critical importance to all the people of the city and would be to the business interests of all the citizens and especially of those who may profit from tourist traffic. Since the epidemic began, the city health forces have been augmented by the temporary detail of two sanitary engineers and one sanitary inspector from the provincial health department. This provincial force took charge of the milk plant and the creamery of the Montreal Dairy Co., Ltd., on May 21 and apparently has managed them since in a highly efficient manner.

The Montreal Dairy Co.'s milk plant was receiving and distributing in the city, when the epidemic began, from 6,000 to 8,000 gal. of milk a day. This amount has been reduced to about 2,000 gal. a day since May 21. The milk diverted from this plant, is, according to our information, going in part to creameries in the surrounding country, where it is made up into cheese, and in part to other milk plants in the city. As there is yet a definite possibility of typhoid infection being derived from some of the dairy farms which formerly were supplying the Montreal Dairy Co. plant, rigid official supervision of milk from these and neighboring farms throughout its course from its sources to its consumers in Montreal or elsewhere is important. With the large number of human foci of potential typhoid infection now in Montreal, and in view of the inefficiency of precautionary measures to prevent secondary infections from existing patients and convalescents, the inadequacy of the sanitary inspection force for milk and other food establishments and the fact that the number of new cases of typhoid fever reported for the ten days ended June 28 averaged over 10 a day, it is obvious that from a typhoid fever standpoint Montreal is not yet a comparatively safe city for visitors and is not likely to become such until much more efficient local health service is established.

It is apparent that the biggest factor in the prevention of secondary cases in the epidemic has been the hospitalization of a large number of the primary cases—about one-third of the total cases reported. The bedside prophylaxis at the hospitals generally—both the emergency hospitals for typhoid cases and the permanent hospitals—impressed us as being painstaking and efficient.

The large volume of milk, cream, butter and cheese shipped from the general vicinity of Montreal into the United States is not now officially controlled at its sources so as to give satisfactory assurance of its freedom from typhoid or other dangerous infection at any time. To remove such menace to the health of the people of the United States provision should be made at once for effective processing of such foods under adequate official supervision at the places to which they are shipped before they are distributed to the consumers.

Conclusions—(1) The typhoid fever epidemic in Montreal, Canada, since Feb. 15, 1927, was beyond reasonable doubt caused by infection distributed in the output of milk from the plant of the Montreal Dairy Co., Ltd., in that city. (2) Though contributory infection may have been introduced into the milk at one or more of the four stations or within the plant in Montreal the preponderance of evidence is that the bulk of the infection was introduced into the milk at the farm sources and was enabled to multiply before the milk reached the city plant. (3) Though it was barely possible for a very small proportion of whatever infection was in the milk to pass through the pasteurization machine without being heated long enough and at a high enough temperature to be destroyed, the preponderance of evidence is that a very considerable proportion of the infected milk was passed through and distributed from the plant without being subjected to pasteurization treatment. (4) A large proportion of the milk which at the beginning of the epidemic was distributed through the plant of the Montreal Dairy Co., Ltd., and which is now presumably being distributed through other plants or channels to consumers in Montreal and elsewhere is not now being officially controlled in such manner as to preclude its possible menace to the public health. (5) *Montreal is not yet a comparatively safe city for visitors who are likely to be susceptible to typhoid fever infection.* [Italics ours.—EDITOR.] (6) Milk and milk products derived from sources within the general vicinity of Montreal do not appear to be produced or processed under satisfactory sanitary conditions nor under official health supervision approaching adequacy.

Recommendations—It is recommended (1) *That state and local health officials and other persons concerned be advised that Montreal is not now, from a typhoid fever standpoint, a comparatively safe city for tourists from the United States to visit and is not likely to be such for months yet to come, unless local health service in the city of Montreal and the vicinity thereof promptly is made much more nearly adequate than it now is.* [Italics ours.—EDITOR.] (2) That such steps as may be necessary be taken to encourage or bring about under proper official supervision radical improvement in sanitary conditions under which milk and milk products are produced, handled or processed in the city of Montreal or at any other place in the Province of Quebec within a radius of 100 miles of the city of Montreal for export to the United States; and that such milk or milk products after reaching points to which shipped in this country and before being distributed to consumers be pasteurized or otherwise processed under official supervision so as to be rendered free from typhoid, tuberculosis or any other infection likely to endanger human health.

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

Hydraulics Differently Treated

REVIEWED BY JOHN H. GREGORY

Consulting Engineer; Professor of Civil and Sanitary Engineering, The Johns Hopkins University, Baltimore, Md.

HYDRAULICS—By Ernest W. Schoder, Professor of Experimental Hydraulics, Cornell University, and Francis M. Dawson, Professor of Hydraulics, University of Kansas. New York and London: McGraw-Hill Book Co., Inc. Cloth, 6x9 in.; pp. 371; 179 cuts. $3.50.

This book is written to supply a nucleus for a basic course in the hydraulics of engineering. It is therefore more for the use of the student than for the practising engineer. The treatment of the subject is quite different from that met with in other books on hydraulics and is divided into four stages: (1) Description of the physical phenomena, particularly from the engineer's viewpoint; (2) development, when necessary, of the fundamental laws into useful formulas, but with the emphasis kept on basic facts and on the rectification of approximate theory by coefficients from experimental data; (3) presentation of numerous examples showing good form in the analysis and good methods in the solution of problems, with many comments on salient features; and (4) inclusion of many typical problems mostly drawn from practical engineering cases.

The authors say "it seems appropriate to state their belief that students will be given needed orientation and stimulus by preliminary demonstration lectures or parallel laboratory work." In the writers' opinion, in most instances, parallel laboratory work will not suffice and preliminary demonstration lectures would be necessary. The individual instructor would therefore have to decide for himself whether he preferred the type of book which requires preliminary demonstration lectures or one which does not. If his choice should be for the type requiring preliminary demonstration lectures then he will find the book under consideration a most excellent one.

The subject matter is treated in 19 chapters and 5 appendices and covers most of that ordinarily found in books on hydraulics, although presented in a somewhat different manner. There are, however, omissions here and there which the practising engineer will regret, as for example, the hydraulics of various types of conduits, such as the horseshoe, egg-shape, V-bottom, etc., in fact, practically all the conduits in common use, other than the circular. Again, one would expect to find at least one diagram illustrating the relation between the hydraulic elements of a conduit flowing full and partly full.

There are several very commendable features, as the treatment of simple and differential U-tube gages, several new types of diagrams to facilitate computations, an excellent chapter on logarithmic plotting (not easily found elsewhere), and a discussion on the flow of oil in pipes. The book is replete with illustrative problems and their solution, to say nothing of the unusually large number of classroom problems, with answers in most cases, 325 in all.

In a second edition the reviewer would like to see a more extended treatment of the Venturi meter illustrated, especially with a mercury differential U-tube gage, and he wonders how many students as well as practising engineers, to say nothing of some professors of hydraulics have failed to realize the significance of that little expression (sp.gr. of mercury — 1).

The book is a good one and is well written. It is well printed and bound and the cuts are well executed. It has a 9-p. index.

Notable Book on Activated Sludge

THE ACTIVATED SLUDGE PROCESS—By Arthur J. Martin, Chartered Civil Engineer, M. Inst. C.E., M. Inst. Water Engrs., M. Cons. E., F.G.S., F.R.San.I., Past President of the Institute of Sanitary Engineers and of the Association of Managers of Sewage Disposal Works. London (England): Macdonald & Evans (8 John St., Bedford Row, W.C.1). Cloth; 6x10 in.; pp. 415; 76 halftones and line cuts, 54 tables. 30 s., net.

When an engineer with so long and intimate an experience with sewage treatment as is possessed by Mr. Martin produces a large volume on a single process of sewage treatment, the fact affords proof presumptive that both the process and the book deserve the serious attention of every engineer concerned with the treatment of sewage. An examination of this volume will change the presumption into a feeling of certainty. The bare fact that so large a book on a single process of sewage treatment is justified is all the more remarkable because throughout this volume the author, both in expressing his own opinions and giving those of others, makes it clear that in many respects the activated-sludge process of sewage treatment is still in an experimental stage. Both the achievements thus far and the promise of the process are justification for giving it such an exhaustive examination as has been done by Mr. Martin. This again is remarkable in view of the comparatively small number and, with some notable exceptions, small size of the activated-sludge plants that have yet been built, notwithstanding the fact that the early ones have been in operation for some ten years.

Mr. Martin's book may be divided into three parts. The first summarizes the history of the activated-sludge process, including various schemes for accelerating the activation of sewage by aeration that go back into the eighties. Many plants are described, large and small. The different methods of air distribution are detailed.

The second division opens with a consideration of the theory and requirements of the process, continues with an interesting and suggestive discussion on the need for preliminary treatment, modes of working, and diffusers. There are then chapters on tank design, air compression, loss of pressure in air mains, appliances for mechanical agitation, power required for agitation, and one in which various methods of agitation are compared. A combination of methods of agitation is then discussed.

The contents of the third division are well indicated by the title of the first chapter in this section, "Position and Outlook." Other chapters deal with cost, cost reduction, and factors affecting the cost of power. Possible lines of advance are then taken up. A chapter is given to the "Sludge Disposal Problems." Finally the latest developments in the activated-sludge process are reviewed.

Appendices give in tabular form particulars of British

plants using (1) diffused air and (2) mechanical agitation, and also tabulated particulars of American plants. Other appendices deal with air compression, loss of pressure in air mains (a large folding table), and power required to overcome service friction. A bibliography of 644 references is included. There are two indexes, one by authors and one by subjects. In the latter, use is made of figures in heavy type to indicate the principal references.

In addition to the thankfulness that should be expressed to the author for having assembled such a vast amount of material on the activated-sludge process between two covers high appreciation should be expressed for the skill shown in condensation and arrangement and particularly in weaving into the volume throughout, and notably in the third section, on outlook, citations from other authors. Nothing short of mastery of the entire literature of the subject would make this weaving in possible

To forestall special inquiries from the many who will doubtless wish to obtain copies of the volume, we regret to say that, so far as we are aware, no arrangements have been made for an American publisher. Purchasers will therefore have to order the volume direct from the London publishers or else from regular dealers. Customs duty and postage added to the English price 30 shillings ($7.30) will bring the cost of the book delivered in this country, up to some $9 or $10 or perhaps more in case it is ordered through a book dealer.

Geology and Engineering

DIE GEOLOGIE IM INGENIEUR-BAUFACH—Von Major a.D. Dr. Walter Kranz, Württ. Landesgeologe. Stuttgart (Germany): Ferdinand Enke. Paper or cloth; 7 x 10 in.; pp. 425; 53 line drawings, 7 plates. Paper, 31.5, linen, 34 reichsmarks, in Germany.

An addition to the small list of books in the field of engineering geology is made by a new German publication. The author throws together various themes, of which some hardly come within the scope of geology. The last third of the book deals with slides, foundations, reservoirs, dams and related matters, in which the geological factor is quite evident. This is likely to be found the most valuable part of the book, to the American reader. The preceding matter deals with groundwater conditions, pollution and filtration of water flowing through the earth, tests of concrete made with a large number of different aggregates, and the utilization of geological advice in the military service.

Fatigue of Metals

MANUAL OF THE ENDURANCE OF METALS UNDER REPEATED STRESS: A Summary of Views and Test Data, With Instructions for Use—Compiled for Designing, Inspecting and Testing Engineers, By H. F. Moore, D.Sc., Research Professor of Engineering Materials, in Charge, Investigation of Fatigue of Metals, University of Illinois. [Engineering Foundation Publication No. 13.] New York City: Engineering Foundation (29 W. 39th St.). Cloth; 5 x 8 in.; pp. 63; two halftones, four line cuts. $1.

Useful service is done to engineers and manufacturers by the publication of this brief summary of the present status of fatigue studies. Professor Moore, chief worker in the fatigue field during recent years, gives a comprehensive survey of the subject, concise, accurate and highly readable, which, while not covering the full range of the extensive modern investigations, gives sufficient information to supply a thoroughly sound and efficient guide to the engineering use of material.

Steel, naturally, is given predominating attention, though the reader will probably gather intuitively that other metals behave similarly. Because of the small compass of the booklet not all the facts of endurance could be mentioned, among them the fact that cast iron has just as definite a fatigue limit as steel; that outside the field of steel a high strength may be associated with a very low endurance limit, and that in some of these cases, at least, the effect of corrosion is particularly pronounced; that in many instances it is possible to raise the endurance limit by preliminary stress repetition below the initial limit; and that there appears to be some relation between chemical and structural homogeneity on the one hand and fatigue resistance on the other, though this subject is still largely unexplored. However, as the essential purpose of the manual, namely, to set forth and drive home the chief facts and teachings of modern fatigue study, might have been weakened by including too many of the minor points, the author's plan of holding the presentation down to a minimum seems excellent. The book commends itself unreservedly to a wide circle of readers.

Legal Aspects of Zoning Summarized

LEGAL ASPECTS OF ZONING—By Newman F. Baker, A.M., J.S.D. of the Missouri Bar. Chicago, Ill.; the University of Chicago Press. Cloth; 6x8 in.; pp. 182. $2.50.

In considerably less than two hundred pages, the author reviews the evolution of zoning, state and local legislation on the subject, the function of zoning boards of appeal, the legality of zoning, and the special problems of metropolitan or regional areas. Extensive reference lists are given at the end of each chapter. The book will serve the needs of all who are not called on to go deeply into the subject. The poorest feature of the book is the index, which fills only two pages and is utterly inadequate. So scanty is the index that it includes no direct reference to the ruling decision of the U. S. Supreme Court in the Euclid, Ohio, case, to which the text gives considerable space.

Publications Received

QUALITIES AND TEST METHODS of limestone for sewage filters are discussed in a 21-p. pamphlet by J. E. Lamar, published by the Illinois Geological Survey, Urbana, Ill.

A TESTING LABORATORIES DIRECTORY has been prepared by the U. S. Bureau of Standards (15c. from Superintendent of Documents, Washington, D. C.). It includes 207 commercial testing laboratories, together with the types of commodities they test, and also the names of 143 colleges which are doing research work.

GRADE-CROSSING ELIMINATION as proposed for Elmira, N. Y., is described in a report published by the Technical Advisory Corporation, consulting engineers, 15 Park Row, New York City. The plan calls for elimination by elevation along the present routes either by embankments, on fills restrained by retaining walls, or by viaducts.

A COLLECTION of 58 short papers on water supply, water treatment, water-works plants, flood control, sewage disposal and laboratory studies makes up the main part of the 400-p. *Proceedings* of the ninth Texas water-works short school. ($1, from V. H. Ehlers, secretary of the Texas section, Southwest Waterworks Association, Capitol Station, Austin, Texas.)

RACK RAILWAYS on the Abt system are the subject of a 49-p. illustrated pamphlet issued by the Swiss Locomotive & Machine Works, of Winterthur, Switzerland. Both the rack construction and the locomotives are described. A list of 71 Abt rack railways built in various parts of the world

from 1884 to 1925 includes only one line in this country; which is the Pike's Peak Ry., built in 1890.

LATH FILTERS for the treatment of skim-milk solutions (dairy waste) are the subject of a bulletin issued by the Engineering Experiment Station, Iowa State College, Ames, Iowa. The authors are Max Levine, bacteriologist, George W. Burke, chemical engineer, and Clair S. Linton, assistant bacteriologist. The filter used consisted of six tiers of lath, 2 ft. square by 1 ft. deep, with 4 in. of interspace for sampling and additional aeration. The results were good.

THE POWER SITUATION in the Southern Appalachian States is outlined in a reprint from the April 21 and 28, 1927, issues of *Manufacturers Record*. The papers are by Thorndike Saville, professor of hydraulic and sanitary engineering, University of North Carolina, and chief hydraulic engineer of the North Carolina Department of Conservation and Development. Included in the reprint is a map of the southeastern region showing the location of power stations and transmission lines.

STANDARDS FOR THE DESIGN, Construction, Equipment and Operation of Swimming Pools and Other Public Bathing Places, formulated after years of work by a Joint Committee of the Public Health Engineering Section, A.P.H.A., and the Conference of State Sanitary Engineers, are printed in Vol. IX, *Journal*, American Association for Promoting Hygiene and Public Baths (Arthur M. Crane, treasurer, P. O. Box 508, Hammond, Ind.). The volume contains other material on public bathing places, including a summary of state control.

AN OUTGROWTH of an official visit to Great Britain in 1926 by H. W. Streeter, sanitary engineer, U. S. Public Health Service, to join an "interchange of sanitary engineers" held "under the joint auspices of the League of Nations and the British Ministry of Health," composed of 17 engineers from as many countries, is an interesting Public Health Bulletin of 56 pp. taking up, more particularly, British water supply and sewage disposal practice as observed at a number of places. Attention is also given to refuse disposal, city planning and municipal housing. (15c. from Superintendent of Documents, Washington, D. C.)

HIGHWAY CULVERT STUDIES forming a part of the highway research investigation conducted at Ames, Iowa, by the Iowa Engineering Experiment Station and the U. S. Bureau of Roads are reported in bulletins entitled (1) Concrete Cradles for Large Pipe Conduits, by W. J. Schlick, drainage engineer, and James W. Johnson, assistant engineer, and (2) Experimental Determinations of Static Impact Loads Transmitted to Culverts, by M. G. Spangler and Clyde Mason, assistant engineers, and Robley Winfrey, bulletin editor. The usefulness of the bulletins is not confined to those concerned with highway design and construction.

SYSTEMS OF TRAFFIC CONTROL by electric signals as used in the cities of New York State are considered in a report just made public by the Joint Committee on Traffic Control Signal Systems of the New York State Conference of Mayors and Other Municipal Officials and the Empire State Gas & Electric Association. Besides reviewing present practices in New York State cities, the booklet suggests a number of uniform standards and gives considerable information regarding traffic signals and their use and operation. The report may be obtained from William P. Capes, secretary, New York State Conference of Mayors and Other Municipal Officials, Albany, N. Y.

COMPARATIVE TESTS of 6-in. American and French Cast-Iron Pipe, reported on by S. N. Petrenko, U. S. Bureau of Standards, in a 24-p. illustrated pamphlet, show "that the strength of the French pipe lay within the range of variation of the American pipe" and that the French pipe was "characterized by greater hardness, low impact values, and a higher content of phosphorus (about 85 per cent) than in American pipe." The substitution of rings for bars for transverse test is suggested. Four pages are devoted to a discussion of methods of testing cast-iron pipe—Brinell, flexure, shear, impact and hydrostatic. (15c. from Superintendent of Documents, Washington, D. C.)

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

A CENSUS ANALYSIS OF AMERICAN VILLAGES, Being a Study of the 1920 Census Data for 177 Villages Scattered Over the United States—By C. Luther Fry. [Institute of Social and Religious Research, American Village Studies, Edmund DeS. Brunner, Director.] New York: Institute of Social and Religious Research (370 Seventh Ave.). Cloth; 6x9 in.; pp. 165; tables, charts and maps. $2.50.

A study of agricultural villages of less than 2,500 population. Tables are presented and discussed for Middle Atlantic, Southern, Mid-Western and Far-Western villages. Finally, there is a summary for the entire 177 villages.

DESCRIPTIVE GEOMETRY—By C. H. Schumann, Jr., C. E., Assistant Professor of Drawing, Columbia University. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. 248; 164 line cuts. $2.50.

DRAFTING FOR ENGINEERS: A Textbook of Engineering Drawing for Colleges and Technical Schools—By Carl Lars Svensen, M.E., Professor of Engineering Drawing, Texas Technological College, M. A.S.M.E., M. S.P.E.E., Formerly Professor of Engineering Drawing, Ohio State University. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. 363; 583 line drawings and halftones. $2.75

ENGINEERING FACTS CONCERNING THE SANITARY DISTRICT OF CHICAGO. Chicago, Ill.: The Sanitary District of Chicago. Paper; 6x9 in.; pp. 71; one map, 9 halftones.

A concise illustrated description of Chicago's drainage canal and various district sewage-works, completed and under construction.

HYDRAULICS—By Ernest W. Schoder, Professor of Experimental Hydraulics, Cornell University, and Francis M. Dawson, Professor of Hydraulics, University of Kansas. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 371; 179 line cuts and halftones. $3.50. (Reviewed on p. 111).

LEGAL DECISIONS AFFECTING THE FINANCING OF UTILITIES—By Cecil F. Elmes. Presented before the 47th Annual Convention of the American Water Works Association, June 8, 1927. Chicago, Ill.: Cecil F. Elmes Organization. Paper; 10x12; pp. 28; one chart. (Complimentary distribution.)

MANAGEMENT AND METHODS IN CONCRETE HIGHWAY CONSTRUCTION—By J. L. Harrison, Highway Engineer, U. S. Bureau of Public Roads. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 242; 74 halftones and line cuts. $3.

MUNICIPAL INSURANCE: A Survey of the Practices of Cities in Insuring Their Property and Liability Risks—By Orin F. Nolting, Secretary, Municipal Reference Bureau. [Bulletin 63.] Published jointly by the International City Managers' Association and the League of Kansas Municipalities. Lawrence, Kansas: The Municipal Reference Bureau, University Extension Division, University of Kansas. Paper; 7x10 in.; pp. 62. $1, postpaid; 3 copies for $2.50, postpaid.

Summarizes the relatively few state laws on the subject and outlines practice, chiefly as to fire insurance. Contains a few paragraphs on workmen's compensation.

POLLUTION OF STREAMS IN ILLINOIS. Bulletin 24, Division of State Water Survey (A. M. Buswell, Chief), under Department of Registration and Education (A. M. Shelton, Director). Springfield, Ill.: Published in Co-operation with the Department of Conservation, Wm. J. Stratton, Director, Frank A. Abbey, Assistant Director. Paper; 6x9 in.; pp. 33; state map, and 21 plates of sections and charts.

Contains drainage area maps showing location and relative volume of pollution of streams; also condensed descriptions of sewage disposal for each town in each county, with notations where sewerage systems are lacking.

PROCEEDINGS OF THE FIRST CONFERENCE OF SEWAGE-WORKS OPERATORS, Held at Pennsylvania State College July 13-14, 1926. [Technical Bulletin No. 1, The School of Engineering.] State College, Pa.: Pennsylvania State College. Paper; 6x9 in.; pp. 55.

STANDARD CONSTRUCTION METHODS—By G. Underwood, Construction Engineer. New York and London: McGraw-Hill Book Co., Inc. Leather; 6x9 in.; pp. 407; 330 line cuts and halftones. $5.

STREAM GAGING—By William A. Liddell, Department of Civil and Sanitary Engineering, Massachusetts Institute of Technology. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 238; 137 halftones and line cuts. $3.

TECHNOLOGY AND USES OF SILICA AND SAND—By W. M. Weigel. [Bulletin 266, Bureau of Mines, Scott Turner, Director.] Paper; 6x9 in.; pp. 204; 50 line cuts and halftones. 40c. from Superintendent of Documents, Government Printing Office, Washington, D. C.

UNITED STATES GOVERNMENT MASTER SPECIFICATIONS FOR CEMENT, PORTLAND: Federal Specifications Board Specification No. 1a. [Circular No. 33, Bureau of Standards, George K. Burgess, Director.] Paper; 7x10 in.; pp. 18; 9 halftones and drawings. 10c. from Superintendent of Documents, Government Printing Office, Washington, D. C.

WATER METERS AND THE ELIMINATION OF WASTE: A Study of New York City's Water Supply Problems. Compiled by the Water Works Research Bureau, 50 E. 42nd St., New York City. Paper; 5x8 in.; pp. 36.

Arguments for metering New York water supply supported by quotations from various engineers and by tabular data.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Comment on Recent Design Practice for Concrete Roads

Sir—Articles on road design during the past year have shown the remarkable progress which has been made recently in this branch of civil engineering. There are, however, a few points which I think should be mentioned, theoretical though they may seem.

The present methods of curing by blanketing with earth and spraying continuously with water, ponding, or covering with a deliquescent appear to be inadequate for preventing rapid evaporation, and in several instances have been unsatisfactory. The purpose has been to balance the surface evaporation by adding more water, and the amount of water necessary is the same for a 6-in. slab as for a 6-ft. slab. After the pavement has been uncovered, however, shrinkage stresses reach a maximum within a relatively short period under dry weather conditions; and as the road is usually opened to traffic at the same time, the stresses in the concrete are increased by the live-loads.

Shrinkage stresses are caused for the most part by capillary pressure of the water in the concrete, and vary with the permeability of the concrete, rate of drying, and depth of slab. Surface flaking may be cited as an example of extreme conditions. Shrinkage first causes contraction in the top of the slab, and this is resisted by the unchanged conditions below. The lower part of the slab lags in shrinkage because stresses in the water are slow to equalize, and the water in turn is held back by the relatively low permeability of the concrete. As time goes on, the average stress is sufficient to overcome the friction of the subgrade, and movement results. Any steel tends to resist this movement if the bond does not fail. Steel does not act with the concrete in shrinkage as it does in temperature. Shrinkage is somewhat similar to the drying out of saturated soils, as explained by Dr. Terzaghi in his "Erdbaumechanik" (Terzaghi, Charles, "Erdbaumechanik," Franz Deuticke, Leipzig und Wien, 1925, pp. 153-183).

It may be suggested that an impermeable surface coating —paint, emulsified asphalt, or similar material—that will harden within a few hours, that will adhere to the concrete after the initial set has taken place, that can be easily applied by painting, mopping, or spraying on the top surface and sides, would prevent surface evaporation. After the side forms are removed, and the sides protected and banked with earth to prevent any possible circulation of air under the slab, the dead air spaces under the slab would reduce evaporation and absorption to a minimum.

The color of the material used to protect the concrete might be varied to suit temperature conditions—white in summer to reflect heat, and black or some other dark color to absorb heat in cooler periods.

The slow wearing off or pounding in of the coating would permit the pavement to dry out slowly and allow for the adjustment of stress between the top and bottom as well as throughout the section.

Planes of weakness are a recent innovation with many good points. Such planes should have dowels running through them—similar to expansion joints—to maintain alignment. These dowels would not need spaces at the end to prevent crushing of the concrete since this type of joint is purely a contraction joint. The ends and corners of the slab should have additional thickness or reinforcement similar to that at the expansion joints, since those areas have less strength in resisting loads.

A theory of the spacing of joints may be built up on an analogy with Dr. J. A. L. Waddell's economical length of spans for bridges (Waddell, J. A. L., "Bridge Engineering," John Wiley & Sons, Inc., New York, 1916, II, pp. 1187-88). It is always possible to place enough steel in a slab to carry the tensional forces of friction between the slab and the subgrade; so a theory of spacing will have to rest on the basis of economy. It may be suggested that the contraction joints, or planes of weakness, be spaced so that the cost of the plane of weakness, plus dowels, plus end of slab and corner reinforcement or extra thickness of slab, be equal to the cost of the longitudinal temperature reinforcement.

The spacing of planes of weakness, or contraction joints, for plain concrete slabs would be limited by the tensional resistance of the concrete in carrying the frictional resistance of the slab on the subgrade. When we have advanced to the use of planes of weakness, all slabs will be reinforced.

Expansion joint spacing is limited solely by the unsupported slightly eccentric columnar crushing strength of the slab in compression when the maximum width of joint is unlimited.

The ratio of expansion joints to planes of weakness, or contraction joints, is dependent on the temperature at which the concrete is placed and on the local range of temperature in relation to this "placing" temperature. If concrete is placed in cold weather, one may expect little or no contraction other than shrinkage, but a maximum of expansion; conversely, if concrete is placed in hot weather, we get a minimum of expansion and a maximum of contraction plus shrinkage. Additional moisture has the same effect on the unprotected concrete as increased temperature until the saturation point is reached. Reducing the moisture or water content of concrete causes shrinkage until the shrinkage limit is reached.

LE ROY M. HERSUM,
Assistant Engineer, Bridge Department,
Massachusetts Department of Public Works.

Boston, Mass.,
June 29, 1927.

Torsion Tests of Concrete Cylinders

Extensive tests of the torsional resistance of cylindrical concrete test pieces have been carried out by Takenosuke Miyamoto, civil engineer in the Bureau of Public Works, Japanese Home Department, Tokyo. The tests included 16 plain and 78 reinforced test pieces, 12 in. in diameter by 36 in. in gage length, with enlarged heads, making the total length 60 in. The reinforcement included 45-deg., 60-deg. and 30-deg. spirals, combinations of spirals with longitudinal bars, with rings, and with both bars and rings, and a few test pieces with an outer and an inner spiral, some of these having also longitudinal bars. Failure occurred in all cases in helical lines, at right angles to the principal tension, at about a 45-deg. angle. The plain concrete cylinders broke immediately at the development of the first crack, while the reinforced-concrete cylinders not only reached a higher stress at first crack but developed further resistance beyond this point. The 45-deg. spiral reinforcement was the most effective, the 60-deg. spiral next, and the 30-deg. spiral least effective. The torsional strength was slightly increased by longitudinal bars as well as by rings, the latter being slightly more effective. Reinforcement of longitudinal bars and rings alone did not prove of definite value, however. The test pieces with double spirals (inner and outer) showed somewhat higher resistance than those with single spirals, and a slight further gain in strength was obtained through the addition of longitudinal bars to the double spirals. Mr. Miyamoto says further that "at the maximum value of the torque, the resistance of the concrete against tension, especially that of the solid core, is not yet exhausted, and at the same time the reinforcement is not yet stressed up to its breaking point, the twist thus being resisted partly by the concrete and partly by the steel."

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Montreal Council Returns Plant to Water Company

Protracted litigation over the purchase by the city of Montreal of the water-works system of the Montreal Water & Power Co., supplying a part of Montreal and some of its suburbs, led to a demand by the company for a return of the property, held and operated by the city since March 1. Accordingly, on June 12, the city council voted, 28 to 4, to return the plant. It was alleged that the price of $14,000,000 which the city agreed to pay for the works was excessive, as the property changed hands near the end of 1926 for some $10,000,000, and that the price ought to be determined by arbitration. Appointment of arbitrators by the city and company to set a price not in excess of $14,000,000 was followed by temporary injunctions against the arbitration proceedings and against payment by the city of the $14,000,000 that had been agreed on. The situation was further complicated by a suit for libel brought by a member of the city council against a local newspaper because of criticisms of the purchase by the newspaper.

It is reported that as soon as all the purchase and arbitration proceedings of the city council except the vote to return the works have been nullified by the council, a new arbitration board will be created.

Aerial Survey of Rio Grande Is Started

The First Photo Section of the Army Air Corps, now located at Fort Sam Houston, Texas, has commenced work on an aerial mapping project for the commission on the equitable use of the waters of the lower Rio Grande. This project involves the aerial photographing of an area approximately 280 miles long and 10 miles wide, extending along the Rio Grande, including both the American and Mexican banks, from Rome, Texas, to the mouth of the Pecos River; and of the channel of the Tia Juana River, involving an area 40 miles long and 5 miles wide. These photographs are desired to facilitate the commission's study of the terrain adjacent to the rivers and as an aid in selection of sites for irrigation and power dams.

While engaged in this undertaking, the First Photo Section will also photograph the proposed route of the All American Irrigation Canal. This area is approximately 70 miles long and 5 miles wide.

Within about two months it will be possible to secure by means of this aerial mapping data which would require many months by terrestrial survey.

Missouri Zoning Law Upheld By State Supreme Court

Earlier Decisions Are Reversed—Act Held Valid Exercise of Police Power

EARLIER decisions declaring zoning regulations unconstitutional unless they provide compensation to property owners damaged thereby were reversed on June 11 by the State Supreme Court of Missouri, two of the seven judges dissenting. The decision reversed is one by the Circuit Court of St. Louis which granted an application for a mandamus made by the Oliver Cadillac Co., designed to compel the city of St. Louis to grant a permit for the erection of an automobile salesroom on Lindell Boulevard in a district restricted to multiple-family dwellings, under a city ordinance effective May 26, 1926.

The company urged that the ordinance is void because it takes and damages private property for public use without just compensation, and deprives owners of their property without due process of law and equal protection of law. In its decision the State Supreme Court said:

> The constitutionality of city zoning laws has been so fully and painstakingly considered by so many courts of last resort, including the Supreme Court of the United States, that for us to attempt a general survey of the police power and then point out the particular features of such laws which bring them within the constitutional sphere would be a work of supererogation. We, therefore, deem it sufficient to say that we are in accord with predominant judicial opinion which holds that an ordinance of the general character of the one involved in this case is a valid exercise of the police power.
>
> The Legislature of Missouri has authorized municipalities to divide their area "into districts and within such districts [to] regulate and restrict erection, construction, reconstruction, alteration or the use of buildings, structures or lands. * * * Such regulation, however, should be made in accordance with a comprehensive plan, designed to lessen congestion in the street, to secure safety from fire, panic and other dangers; to promote health and the general welfare; to provide adequate light and air; to prevent the overcrowding of the land; to avoid undue concentration of population; to facilitate the adequate provision of transportation, water, sewage, schools, parks and other public requirements. And this the ordinance under consideration, purports to do. If its provisions may be regarded as reasonably appropriate means of accomplishing the ends so specified, it is a valid exercise of the police power. * * * [a point for] determination * * * by the legislative body which passed the ordinance.
>
> Zoning by condemnation under the power of eminent domain would tend to fossilize a great city and thereby defeat the essential purpose of the zoning. It must, therefore, be zoned under the police power or not at all.

The two judges who dissented held to the earlier decisions of the court that the effect of zoning is to take private property for public uses without compensation.

E. J. Mehren Back from Industrial Study of Europe

Edward J. Mehren, vice-president of the McGraw-Hill Publishing Co., returned from a two and a half months trip in Europe on July 12. During his absence Mr. Mehren spent three weeks at the International Economic Conference in Geneva, a week in Northern Italy, three weeks in Germany and a week in attendance at the Stockholm Congress of the International Chamber of Commerce. In Germany he divided his time between Berlin and the industrial regions of the Ruhr and the Rhineland, studying industrial conditions, interviewing engineers, manufacturers, bankers and labor leaders, and visiting industrial plants.

His visit to Stockholm was made to learn what action the International Chamber of Commerce would take on the Geneva resolutions. He reports that the International Chamber endorsed the Geneva conclusions and called upon its national committees in the several countries to bring pressure on their governments to pass the legislation necessary to make the Geneva conclusions effective.

While abroad Mr. Mehren traveled 1425 miles by airplane. On his last flight he traveled from Malmö, Sweden, to London, flying 686 miles, setting foot in one day in five countries (Sweden, Denmark, Germany, Holland, and England) and flying over two others (Belgium and France.)

Northern Pacific Ry. to Replace Twenty-five Mile Line

Authority to abandon its Bitter Root branch in Montana and to construct a new line on the opposite side of the Bitter Root River has been asked of the Interstate Commerce Commission by the Northern Pacific Ry. The present line is 25.7 miles long and the new line will be of approximately the same length. It will serve industries to be developed in that region. If the authority is granted the company expects to start construction in time to have the new line completed by the end of June, 1928. The cost is estimated at $861,000.

New Earthquake Insurance Rates on Pacific Coast

Buildings Classified Both As to Geographical Location and Type of Construction

INSURANCE companies on the Pacific Coast have recently adopted new rates for insurance, worked out by the Board of Fire Underwriters of the Pacific. These rates are so much higher than any heretofore asked that they are claimed to be having an adverse effect on building construction.

The present situation is understood to be transitory but it is not yet apparent just what the outcome will be. The California State Association of Managers of Savings Banks, an organization very much concerned with mortgage loans on dwellings and business blocks, is reported to be considering withdrawing its present requirement for earthquake insurance and, instead, to be guided in the placing of each loan by an engineer's report on the building in question.

Building Classification

The new insurance rates, put into effect in May, classify buildings, both as to location and as to type. The geographical classification is an attempt to correlate the damage risk with fault lines and with areas which have had more severe earthquake experience than others. Five zones are established, ranging from minimum rates in Nevada and Alaska to a maximum in Imperial County, at the southern border of California. The zones and their basic rates are:

Zone I, Alaska and Nevada, basic rate 0.12; Zone II, central part of California, 0.20; Zone III, eastern, western and southern California, 0.25; Zone IV, Riverside and San Bernardino Counties, 0.30; Zone V, Imperial County, basic rate 0.37.

Six classes of construction beginning with that of lowest rate (basic rate) and progressing to that of highest rate, are as follows: Class 1, frame dwellings, small frame apartment buildings and frame private barns and garages in connection therewith; Class 2, buildings of steel frame and masonry floors and walls wherein the load is entirely carried by the frame, all-steel buildings on solid foundations, steel tanks on solid foundations, and outdoor electrical substations; Class 3, frame or stucco buildings of good construction not over three stories in height or having a ground floor area of not more than 4,000 sq.ft., as well as marine railways; Class 4, buildings of reinforced-concrete construction having reinforced-concrete frame, and buildings of steel frame with masonry floors and walls wherein part of the load is carried by masonry walls or partitions; Class 5, buildings having brick, stone or poured concrete walls wherein the loads are carried in whole or in part by such walls and partitions, excluding buildings constructed of tile, concrete block, masonry veneer on wood frames and adobe, and including all frame buildings except those previously listed; Class 6, buildings of tile, concrete blocks or adobe bearing walls, masonry veneer on wood frame, dams, reservoirs, bridges and all other types of construction not above mentioned.

As to contents of buildings, certain contents take rates 25 to 50 per cent lower than the building rate, and stock in sprinklered buildings takes a rate 10 per cent higher than the same stock in unsprinklered buildings. A deductible clause of at least 10 per cent must be made part of the policy.

The rates for these six classes in the five geographical zones are tabulated as follows:

NEW EARTHQUAKE INSURANCE RATES

Class	1	2	3	4	5	6
Zone I....	0.12	0.30	0.40	0.75	1.40	1.75
Zone II....	0.20	0.45	0.60	1.15	2.10	2.70
Zone III....	0.25	0.60	0.80	1.50	2.75	3.50
Zone IV....	0.30	0.75	1.00	2.00	3.40	4.40
Zone V....	0.37	0.90	1.20	2.25	4.15	5.25

Most of the large office buildings of California are in the third zone, which includes San Francisco and Los Angeles. Here the new rate is 60c. per $100 for a steel frame building and $1.50 per $100 for a reinforced-concrete building, almost three times the former rates.

It is reported also that in spite of this increase in rate, it is now not possible in all cases to get as much earthquake insurance as is desired. On a $5,000,000 office building recently completed, the lenders were led to believe that insurance of $3,000,000 would be carried, but subsequently it proved to be difficult to obtain more than $1,000,000 of insurance on this structure.

Engineering Fifty Years Ago

From *Engineering News*, July 21, 1877

THE Delaware Bridge Co. have contracted with the Pennsylvania Railroad Co. for a bridge at Rockville station, to cross the Susquehanna River just above Harrisburg. A. & P. Roberts & Co., Pencoyd Iron Works, make nearly or quite all of the iron. The Edge Moor Iron Co. do the fitting and prepare the iron for erection. The aggregate weight of iron will be about 7,000,000 lb. The bridge will be completed before December next.

Rates Lowered in Flood Area

Railroads in the Mississippi Valley have informally agreed to make freight rate reductions on road building material used for the restoration of the flood damaged roads in the lower valley. When such reductions are made the amount saved thereby will be considered by the Bureau of Public Roads as state contributions to highway work and will be matched by federal funds.

Correspondence Schools to Improve Practices

Representatives of 60-Odd Institutions Doing 80 Per Cent of Business Meet in Pittsburgh

REPRESENTATIVES of over 60 correspondence schools, which conduct about 80 per cent of the volume of business in that field, met in Pittsburgh on April 30 under the auspices of the Federal Trade Commission, to take steps to improve their practices and put the business on a higher plane. The results of the meeting have just been made public by the commission.

The conference was presided over by Commissioner Nugent, who pointed out to the members present the various forms of practice which have been complained of to the commission.

Resolutions Adopted

After various points had been discussed, the conference adopted a number of resolutions concerning the subjects under discussion. The gist of the resolutions is as follows: The following are considered to be unfair practices; overstatements or misrepresentations relating to actual or probable earnings; overstatements which set forth the demands and opportunities in any vocation; to represent employment service in a misleading manner; to promise or guarantee a job or raise in pay; the making of an offer, limited as to time or otherwise, when in fact such offer is not so limited; the representation of an offer as "special," when in fact it is regular; the use of marked-up or fictitious rates for a course of lessons; the offering of a series of reductions in the price of a course or service to prospects, resulting in the concurrent quoting of different prices for the same course or service; and to resort to a subterfuge of offering a scholarship or a partial scholarship that is merely used as a selling device; that the offering of any commodity or service as "free," when in fact such commodity or service is regularly included as part of the course; making disparaging references to a competitor or a competitor's course; using any name which indicates that the institution is a plant, factory, shop, association other than an institution of learning, unless the name of such institution is always used in connection with explanatory work which clearly indicates its nature; conferring degrees or issuing diplomas, except when earned under conditions which offer adequate teaching facilities, and under auspices that conform to recognized standards as to quality and thoroughness of instruction and content of the courses; misrepresenting the character and scope of any course of instruction; to inaccurately list or state the relationship of members of faculties, advisory boards, instructors and others; to claim students by giving personal instruction by the head of the institution or department when such is not the fact; the use of "Help Wanted" columns in newspapers

for the purpose of getting in touch with prospective students; the use of blind advertisements to attract prospective students, when the copy does not clearly set forth that instructions are offered; the enrollment or retention of students in any course for which they are absolutely unfitted by reason of education or economic disqualification; and the use of the word "guarantee" in the description of money back agreement, unless actually guaranteed by a third party; the sending of statements on paper stimulating court documents in the collection of accounts; misrepresentation regarding offices and equipment; misuse of titles or pictures giving the impression that the institution is in any way connected with the United States Government.

These resolutions have been approved by the Federal Trade Commission to become effective Jan. 1, 1928.

Forest and Soil Survey Started in Mississippi Valley

A survey to bring together all available information upon the location and area of forests needed on the Mississippi watershed as a part of flood prevention and control work has been started by the Forestry Service of the U. S. Department of Agriculture and will be completed by the early fall. This survey, according to Col. William B. Greeley, chief forester, will define the main tributaries and will bring together for each one of them the necessary data as to acreage, amount and character of the precipitation, the more essential or more common soil classes, features of physiography, including ruggedness of topography, natural reservoirs, etc., the character of the vegetative cover, and a rating of the value of the protective cover as a means of flood prevention and control.

A somewhat similar rating of the protective efficiency of the existing forest cover on the Mississippi system's watershed is proposed. The plans contemplate putting as much as possible of all these data on a set of maps for ready consultation in the formulation of comprehensive plans for flood prevention. The data obtained by the Department of Agriculture will be correlated with that of the War Department and other agencies for the construction of reservoirs and other engineering methods of flood control.

Short Line Road Applies for Construction Authority

The Gulf & Ship Island R.R. Co. has applied to the Interstate Commerce Commission for authority to construct a new line of railroad from a junction with its main line at Mendenhall to Pelahatachie, a distance of approximately 25 miles. The purpose of the proposed line is to furnish transportation facilities to lumber manufacturers at present inadequately served.

Chicago Plans Big Works with Doubled Bonding Limit

With an additional sum of about $94,000,000 made available for public improvements in Chicago by the passage of a group of revenue bills, the city council is considering an extensive program of construction. These bills, which practically double the city's bonding power, were passed by the recent legislature and have been signed by the governor. According to an official statement the city has on hand about $35,000,000 of bonds which have been approved by public vote for specific improvements, but which could not be issued as the city had reached its former bonding limit of $94,000,000. These works can now proceed, after the bonds have been issued, and in addition other works can be undertaken to the extent of $59,000,000, which will reach the new limit of about $188,000,000.

Bonds approved by public vote last October and aggregating $21,000,000, but which could not be issued until the bonding limit was raised, include the following: Chicago River straightening, with its new streets and bridges, $5,900,000; Wabash Ave. bridge, $3,700,000; Ashland Ave. bridge, $1,625,000; Ashland Ave. widening and improvement, $2,500,000; Western Ave. improvement, $2,000,000; Indiana Ave. improvement, $1,600,000; playgrounds and beaches, $1,000,000; street lighting, $1,700,000; traffic control lights, $200,000. New improvements proposed, but the bond issues for which must first be approved by public vote, include widening LaSalle St. and building the new Ogden Ave. bridge and approaches to connect the two completed stretches on either side of the river. Street improvements constitute a large proportion of these tentative projects, which are now being considered by the city council.

Rivers and Harbors Money Needed for Mississippi Repairs

While no confirmation is forthcoming from the War Department, it is understood in Washington that the Controller General has been asked to pass upon a transfer of $2,000,000 from the River and Harbor appropriation to the flood control fund for emergency use in closing the gap in the levees along the lower Mississippi River. Some $5,000,000 is needed for that purpose. The usual amount of $10,000,000 for river work and flood control on the Mississippi was appropriated for use this year but as the high water fight required the expenditure of $4,000,000 and as another $3,000,000 is needed to take care of committments and essential revetment and dredging work the remainder falls $2,000,000 short of the amount needed to restore the levees to their pre-flood state.

This report from Washington agrees with a statement which Colonel Potter is quoted as having made at the Mississippi River Commission hearing held in New Orleans recently, to the effect that a move is being made to make available to the Mississippi River Commission for levee restoration purposes, the sum of $2,000,000. This money, he said, could be used to make advances to the levee boards whose funds are exhausted in order that there might be no delay in carrying out the repairs which are urgently required.

Montreal Typhoid Shows Still Further Decline

Typhoid cases in Montreal for the five days ended July 19 totaled 14, or under 3 a day, compared with 42, or 6 a day, for the full week ended July 14, the nineteenth of the epidemic. Cases from March 3 to July 19 aggregated 4,886. Deaths from March 12 to July 19 totaled 474, with 11 in the 12 days, July 7 to 19.

An extended report on the epidemic down to June 28, made by three surgeons and a sanitary engineer of the U. S. Public Health Service after nearly two weeks study in Montreal and vicinity, appears on p. 108 of this issue.

Power Plant Operation Effect on River Surge Studied

Observations of the persistence of waves caused by irregular power plant operation, at the instance of the Federal Power Commission, are to be made on a number of rivers of varying characteristics. Studies recently completed by the Oregon-California Power Co. show that the waves produced at its Copco plant on the Klamath River are practically undiminished at a distance of 64 miles from the plant and show only a 25 per cent reduction 132 miles away. The gages at the 64-mile and 132-mile stations were read at 30-min. intervals throughout the day and night for a period of six days.

Similar results previously had been noted on the Pit River. That particular study had an important bearing on the commission's action in assuming jurisdiction over the project at Radford, Va., on the New River. The Klamath results tend to support the exceptions taken by the commission's engineers to claims that these impulses disappear a few miles from the plant.

The studies that have been made and those which will be undertaken are expected to have an important bearing in the consideration of future declarations of intention.

Committee Appointed to Study Baker Project

A committee of three has been appointed by the Secretary of the Interior to pass upon the feasibility of the Baker reclamation project. The committee is composed of the following members: A. J. Wiley, consulting engineer, Boise; Prof. George Severance, State Agricultural College, Pullman, Wash.; and F. B. Linfield, director, Agricultural Experiment Station, Bozeman, Mont.

Washington Notes

THE American River, Water and Power Co., of Auburn, Calif., has applied to the Federal Power Commission for a preliminary permit covering a proposed development on the North and Middle Forks of the American River in Placer County, California. The main reservoir, on Middle Fork, will have a capacity of 100,000 acre-ft. The water from the North Fork is to be diverted and stored in that reservoir. The water from the reservoir will be conducted through 10 miles of canal to power house No. 1, below which point it will be carried another ten miles in canals and tunnels to power house No. 2. In this way 54,380 hp. of primary power can be made available.

AN effort on the part of Muscle Shoals City, a municipality with a population of 500 persons scattered over an area of 12 sq.mi., to secure a lease from the federal government for power from the Wilson dam, is attracting much attention in Washington because of the principles involved. The application of the municipality, in which 31 votes were cast at a recent election, has the active support of national leaders of that school of political thought which subscribes to the theory that the government should become a business institution.

The real question involved, some think, is not one of revenue for the United States as only $800 annually would accrue under the contract if all the 156 residences and 14 business houses of the town were to take electricity at the average rate, nor is the real question the supply of power to an area being used as the basis for a nation-wide campaign for the sale of real estate. They think the objective is to secure a precedent that would be the entering wedge for localizing to the Muscle Shoals area the power output of the Wilson dam and for embarking the government in the business of operating power plants and of selling electricity to the public.

A delegation has visited Washington to insist upon the "priority rights extended to municipalities by the national defense act and by the water-power act." In that statement, however, there was some departure from accuracy as the national defense act gives no priority rights to municipalities and the water-power act is not applicable to such a lease as that proposed.

One of the contentions of the delegation was that "it is unfair for the government to permit the Alabama Power Co. to buy current at two mills per kilowatt-hour and sell it at 10c., within sight of the Wilson dam, thereby making a profit of 5,000 per cent and refusing to allow the public, that owns and built the dam, to be benefited by its own electric power." The delegation also overlooked the fact that it is unlawful in Alabama for a power company to collect a greater or less rate, or for any customer to accept other than the uniform rate prescribed by the Public Service Commission.

THE East Tennessee Development Co. will not amend its application for power rights on the Tennessee River so as to exclude the sites on the Clinch River which are under suspension because of the effect the operation of a dam at Cove Creek would have on Muscle Shoals. Further study of the project makes it even more certain that the plan of development proposed cannot be split up without destroying the value of its two parts.

In order to develop the maximum resources of the river and to provide the best navigation scheme it is apparent that the Cove Creek reservoir must supply seasonal storage for the entire series of power plants along the Tennessee River. This would mean that the power plant at the dam would be closed for eight or nine months of the year. This method of operation could not be followed by a lessee independent of the operators of the sites on the main river. On the other hand, if operated so as to produce the maximum amount of power at the Cove Creek plant the storage would be of little value to the Tennessee River projects, as a large part of the water would be turned into the Tennessee at a time when the other tributaries supplied ample water.

An effort is being made to attach a provision to the Mississippi flood control legislation which would authorize the federal government to built the Cove Creek dam. It is pointed out, however, that the reservoir could not be held empty on the chance that there might be abnormal rains if it is to be used also for power purposes.

Random Lines

Woman Would Tame the "Father of Waters"

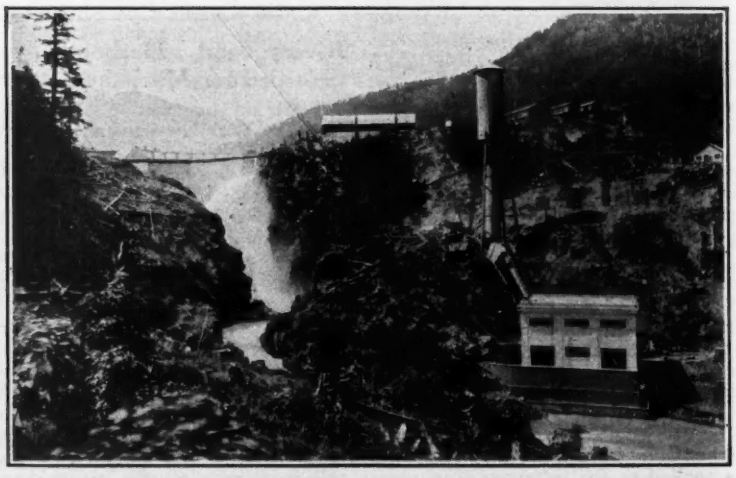
How Dr. Nancy Miller, a woman who has just completed a "survey" of the Mississippi River would solve the flood problem is simply described in the *Boston Traveler*.

Her scholarly report on the famous Boulder Dam is considered by engineers to be a masterpiece of lucidity and authoritative. "The Mississippi can be tamed by harnessing it," she says. "Farmers and small industries along its entire length are demanding power. Coal is costly and steam is out of the question, with this vast river free. A multitude of dams almost from the source, will solve the flood problem and turn this enormous water power into a national great blessing. These various reclamation projects and higher and stronger and wider levees, are mere stop-gap ideas. Surplus water in normal times can be diverted for irrigation, and if politics can be disassociated and sincere effort made, this great benefit can be utilized for the improvement of the whole valley and the subsequent enrichment of the nation. If man will turn his pugnacity to strategic preliminary and harness this river, instead of waiting until trouble comes and then with great noise attack a phase of a problem, we can get somewhere and turn an eternal menace into a perpetual blessing."

And big men, weary of wind and willing to be shown, are giving close attention to this remarkable woman's suggestion toward accomplishing what man thus far has failed to do.

Unfortunately, we did not get a copy of "her scholarly report on Boulder dam." Probably it will get into the Congressional Record before another year and so will be available.

AUTOMATIC HYDRO PLANT PUT IN OPERATION



THE Glines Canyon plant, a 20,000-hp. automatic hydro-electric plant on the Elwha River, Wash., seven miles above a larger power house from which it is operated through selector type supervisory control. This installation was put in service April 29, 1927, and is served by a variable radius arch dam, 210 ft. high, 28 ft. thick at base and 4 ft. thick at top. The dam has a crest length, between abutment and opposite spillway, of only 120 ft. Northwestern Power & Light Co., owner; Thebo, Starr & Anderton, engineers.

Personal Notes

GEORGE W. YATES, assistant deputy minister of the Department of Railways and Canals in Canada, has been appointed acting commissioner of highways for the Dominion Government, to take over the duties of the late A. W. CAMPBELL.

BURTON M. HILL, late minister of public works in the New Brunswick Government, has been appointed chief engineer of the newly-formed Harbor Commission, at St. John, N. B.

THE THOMPSON & LICHTNER CO., INC., of Boston, of which Sanford E. Thompson is president, and William O. Lichtner, vice-president and treasurer, have recently opened offices in New York and Chicago in order to provide closer contact in the engineering fields of management, research, and construction. The New York office is located at 551 Fifth Ave., and the Chicago office at 208 South LaSalle St., Room 1003.

GEORGE T. MCCOY, formerly assistant highway engineer of Washington, at Olympia, and recently chosen by the state highway commission as secretary and technical adviser, has resigned to accept a position with the California State Highway Department.

J. T. MADISON, civil engineer, formerly of Lakeland, Fla., has joined the Kentucky State Highway Department as resident engineer at Lawrenceburg.

J. S. PERCIVAL, who has been an assistant resident engineer for Fuller & Maitland of Kansas City, Mo., is now engaged as a field engineer in tunnel construction for the water board of the city of Detroit, Mich.

J. B. HOKE, formerly assistant engineer in charge of design for the West Virginia State Highway Commission, has joined the organization of Albright & Mebus, Philadelphia, Pa., as construction engineer.

E. C. LARUE, for twenty-three years employed by the United States Geological Survey, has resigned. Mr. LaRue is a graduate of the University of California and has been making studies and surveys of the Colorado River and its tributaries for many years. For some time he was district engineer for the United States Geological Survey at Salt Lake City and since 1917 has made his headquarters at Pasadena. Last year he was called to Washington to appear before the Congressional Committee investigating the Colorado River.

CAPT. HUGH P. ORAM, Corps of Engineers, has been appointed district engineer of the Florence (Ala.) district, Engineer Department at Large, succeeding Lt.-Col. M. C. Tyler, recently ordered to duty at Manila, P. I. The work of the Florence district includes the maintenance and operation of the hydro-electric plant of Wilson Dam (Muscle Shoals). Captain Oram has been on duty at that place as military assistant to the district engineer since 1924 and was in active charge of construction for a year prior to being placed in charge of the district.

W. E. HULSE has been appointed to the newly-created position of supervisor of state-aid roads in the Connecticut State Highway Department. Mr. Hulse was at the time of the appointment supervisor of highways, district 11, comprising the northern section of Hartford County. He has served in the state highway department since 1912 except for the period during the War which he spent overseas with the 23rd Engineers. LEWIS J. FRANCIS, now supervisor of district 3, will succeed Mr. Hulse in district 11, while WALTER H. SPENCER, assistant in district 3, will become supervisor in that district.

C. S. CHRISTIAN, of Texarkana, Ark., chief engineer of the Miller Levee District No. 2, has been appointed state highway engineer of Arkansas to fill permanently the vacancy caused by the resignation of O. L. Hemphill as recorded in these columns June 2, 1927, p. 919. G. Hunter Sykes has been acting state highway engineer since the resignation of Mr. Hemphill.

CHARLES F. SIMPSON has been appointed by the Portland Cement Association as its district engineer for Tennessee, with offices at Nashville, in the Cotton States Building. Prior to joining the association's staff in 1926 Mr. Simpson was engaged in engineering and construction work, in the Field Artillery during the War, and in his own contracting business.

J. B. STARKWEATHER has left the Southern Power Co. for which he was resident engineer on its new steam power development at Catawba, S. C., to enter the firm of Starkweather & Broadhurst, engineers and contractors, with offices at 79 Milk St., Boston, Mass. Mr. Starkweather has served on construction work in Connecticut with the Standard Oil Co. and with Stone & Webster in California, and is a graduate of Massachusetts Institute of Technology.

ALFRED D. FLINN, Yonkers, N. Y., secretary of the United Engineering Society and director of Engineering Foundation, recently received from Louvain University the degree of doctor of science, the diploma being received for him by Dr. Edward D. Adams, of New York, delegate to the ceremonies.

HERBERT E. HUDSON, chief engineer of sewers, Chicago Board of Local Improvements, resigned at the time of the change of mayoralty administration, and is now with the United States Construction Co., Chicago, Ill.

ELMER A. HOLBROOK, dean of the School of Mines and Metallurgy of Pennsylvania State College, has been appointed dean of the School of Engineering and Mines of the University of Pittsburgh, succeeding Dean Bishop who retiring from Pittsburgh, will devote his time to research and teaching, continuing as professor of physics at the university and as consulting engineer to several large Pittsburgh firms.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Boston, Mass., Sept. 13-16, 1927.

ASPHALT PAVING CONFERENCE: Under the auspices of the Asphalt Association and Association of Asphalt Paving Technologists; annual conference Atlanta, Ga., Nov. 28-Dec. 2, 1927.

THE MICHIGAN ENGINEERING SOCIETY will hold its fall meeting at Jackson, Nov. 10 and 11, 1927. Donald M. Hatch is secretary of the society.

Obituary

JOHN C. PAYNE, engineer for the New Jersey Riparian Commission since 1902, died July 18 at his home in Summit, N. J., after a long illness, aged 76 years. Mr. Payne was formerly on the street and water commission of Jersey City and had served other commissions as an engineering expert. He was regarded as an authority on New Jersey waterfront valuations.

JOSEPH W. HOWE, Rochester, N. Y., civil engineer and an inspector of the barge canal harbor at that city, died July 9 aged 58 years. Besides barge canal harbor work, he had designed bridges for the canal and had been connected with some of the state road work near Rochester.

HUGH QUINLAN, Montreal, Canada, contractor, connected with A. W. Robertson, Ltd., engineers and contractors, Montreal, and with many major construction operations, died June 26 aged 70 years. The firm of A. W. Robertson, Ltd., is engaged on section 8 of the Welland ship canal and port dredging. The firm of Quinlan, Robertson & Janin, Ltd., has done extensive paving work in Quebec and Ontario, and is contractor for the south section of the St. Lawrence River bridge now being built at Montreal. Mr. Quinlan was also connected with Fuller Gravel, Ltd., operating large gravel plants and quarries. Further construction work with which he was connected was that of many large office buildings in Canada.

WILLIAM F. ALLISON, professor of municipal and highway engineering at the University of Washington in Seattle, Wash., died at his home in that city on July 10.

CARLOS P. WATKINS, field engineer of the Portland Cement Association, died in Seattle July 1. He has been associated since 1911 in the cement industry in the West.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Research Instead of Publicity for Cast Iron Pipe Bureau

The name of the Cast Iron Pipe Publicity Bureau has been changed to the Cast Iron Pipe Research Association. The change in name develops from the fact that the principal functions of this organization are of a research rather than of a publicity character.

Thomas F. Wolfe, for some time in the city engineer's office in Chicago, devotes most of his time to research and in collecting and distributing information for the association relative to cast iron pipe.

One of the objectives of the association's advertising campaign is the stimulation of interest in cast iron pipe in small towns that have no water-works. When interest in a community reaches the point where action on a water-works system is to be taken, the information is passed out to the different manufacturers of cast iron pipe and the matter is then left to their representatives to handle.

Concrete Road Yardage

For June the square yardage included in concrete pavement contract awards according to the Portland Cement Association was: 8,424,051 for roads; 6,977,602 for streets; and 673,350 for alleys; or a total for the month of 16,075,003 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1927

Month	Roads	Streets	Alleys	Total All Classes
Jan.....	2,656,118	1,504,059	75,352	4,235,529
Feb.....	2,336,031	1,935,262	119,382	4,390,675
March..	5,134,974	3,866,102	298,667	9,299,743
April...	10,264,336	4,931,954	285,924	15,482,214
May....	8,234,755	5,601,627	397,220	14,233,602
June....	8,424,051	6,977,602	673,350	16,075,003
Totals	37,050,265	24,816,606	1,849,895	63,716,766

International Trade Fair Dates Announced

More than 20 countries will display their industrial products with over 7,000 exhibits at the International Trade Fair to be held at Leipzig, Germany, from Aug. 28 to Sept. 3. This industrial fair, which has been held twice each year for centuries, permits buyers to inspect the latest products from widely scattered points and enables exhibitors to bring their products to the attention of a world market. Industries from all over the world will be represented and a great variety of German industrial products will be shown which will appeal particularly to American industry.

The fair is essentially an industrial exchange. Admission to the grounds is only by invitation, thus eliminating sightseers. Every facility will be provided the American visitor. Further details concerning the fair can be secured from the Leipzig Trade Fairs, Inc., 630 Fifth Ave., New York City.

Useful Pump Data Issued in Official Publication

The Hydraulic Society, the trade association comprising the principal manufacturers of displacement and centrifugal pumps in the United States, has published a fourth and complete edition of its useful book of "standards." The 78 pages comprise one of the most practical hydraulic texts so far as pumping requirements are concerned that is available.

One of the most useful sections of the book contains a standard classification table for pumps and many pages of standard definitions of types and terms. Pertinent extracts from standard codes of the American Society of Mechanical Engineers together with drawings are included. Types and parts of displacement and centrifugal pumps are illustrated as well as are those of deep well pumps. Instructions for installation and operation complete the engineering text although several pages of useful graphs are inserted. Recommended contract forms to be used in the pump industry are shown.

This is the fourth edition of the book since 1921. The standard definitions and designs are believed by the Society to be to the mutual advantage of purchasers and users of pumps, and it is hoped "that these recommendations will be considered as the standard trade definitions and customs in the pump industry and will be so used by both buyers and sellers as governing transactions where nothing to the contrary has been established."

Business Notes

GARDNER-DENVER CO., has recently been formed as a consolidation of the Denver Rock Drill Manufacturing Co., Denver, Colo., and the Gardner Governor Co., Quincy, Ill. The new company organized under the laws of the state of Delaware, will acquire all assets of both companies. Each company will probably continue to manufacture its complete line, consisting in the case of the Denver Company of pneumatic hammer drills, and in the case of the Gardner company of compressors. The Denver company has been in business for 21 years, while the Gardner company has been established for 68 years. J. W. Gardner will be chairman of the board of the new company and W. H. Leonard now chairman of the board of directors of the Denver Rock Drill Manufacturing Co., will be president.

PITTSBURGH TESTING LABORATORY, because of the constantly increasing business of its Birmingham, Ala., branch, has had to move into larger quarters in the new Phœnix Building where a completely equipped laboratory has been installed including a 400,000 lb. Riehle Testing Machine said to be the largest commercial laboratory testing machine in the south.

BUCYRUS CO., Milwaukee, Wis., and ERIE STEAM SHOVEL CO., Erie, Pa., are reported to have under consideration a merger of their properties. Negotiations, however, have not yet reached the stage where terms of the proposed consolidation are ready for announcement.

COLUMBUS MCKINNON CHAIN CO., Columbus, Ohio, will move its executive and general sales offices to Tonawanda, N. Y., about the middle of July. The factory in Columbus will remain as a manufacturing unit as heretofore. The company has a large electric welding plant located at Tonawanda.

LAKEWOOD ENGINEERING CO., Cleveland, announces the appointment of the following distributors: T. J. Lane Equipment Co., Springfield, Ohio, for the central Ohio territory, and the Mechanical Supplies Co., Cincinnati, Ohio, for the Cincinnati territory and adjacent Kentucky counties.

LOUISIANA PORTLAND CEMENT CO., New Orleans, announces the appointment of Lewis R. Ferguson, manager, to the office of vice-president and manager.

SACHS BEARINGS, INC., United States and Canadian representatives of Fichtel & Sachs, A.G., Schweinfurt-on-Main, Germany, manufacturers of ball and roller bearings, have opened an office at 114 Liberty St., New York City, with stocks carried also in Cleveland and Chicago.

SELDEN TRUCK CORP., Rochester, N. Y., announces that P. W. Gaylor has been made vice-president and general manager of the Boston branch.

GRAVER CORPORATION, East Chicago, Ind., recently elected the following officers: W. F. Graver, president and treasurer; P. S. Graver, first vice-president; J. P. Graver, second vice-president; K. W. Bartlett, third vice-president; H. S. Graver, secretary; A. E. Lucius, assistant secretary. J. P. Graver, who has long been in charge of the business as president, releases control to his brother, but still remains

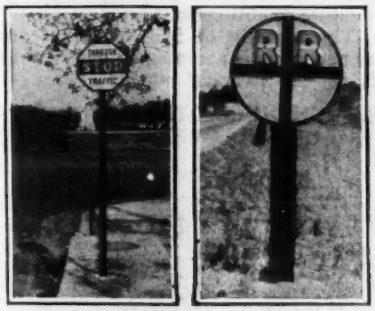
active as vice-president. The two new names on the list of officers are K. W. Bartlett and A. E. Lucius. Mr. Bartlett has been with the company since 1910 and has been general manager for several years. A. E. Lucius has long been legal representative of the company.

New Developments

Reflector Highway Signs Return Headlight Beam to Source

Contrasted to the action in an ordinary mirror where a light beam is reflected at the same angle at which it strikes the surface, the highway reflector signs developed by the American Gas Accumulator Co., Elizabeth, N. J., return the light beam directly to its source. The reflection from an automobile headlight is, therefore, returned to the driver's eyes. This reflective action operates from any angle, vertical, horizontal or oblique, up to 20 deg. from the normal, the total spread of the signal indication being therefore a solid angle of 40 deg.

The signs are known as Stimsonite reflector signs, the important letters being made of glass tiles having on their

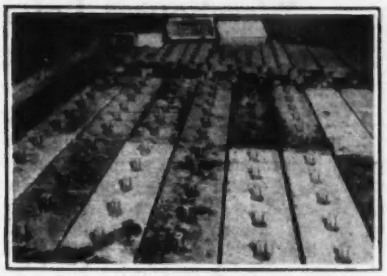


rear face a series of prisms. The secondary wording on the sign is enameled in a color contrasting to the background of the sign. The sign itself consists of a steel plate reinforced and enameled. The important letters or characters are cut out like a stencil, and a shallow steel holder containing the Stimsonite reflector tile is fastened to the plate back of each cut-out. Under the action of headlights the effect is of a sign illuminated from the rear. Under average weather conditions, it is claimed the reflector words are easily seen at night for at least 250 ft. The signs are available in all standard designs and can be manufactured to specifications.

New Filter Bottom

A new type of filter bottom has been installed for the Pennsylvania Water Co. in Pittsburgh by F. B. Leopold Co., Inc., Pittsburgh. One of the main features of the design is to prevent the fine sand from drifting into the manifold.

The header is composed of a concrete conduit, the open top of which is closed with a cover plate fastened down with anchor bolts and grouted into place. In the openings on top of these lateral conduits are set heavy glass nipples which form the distributing orifice. On top of this primary system, the second system of 1x2-ft. interlocking hollow blocks, closed on one end and corrugated on top. The holes in the tops of these blocks have an area designed to reduce



the velocity of the water of the primary system to about one-fifth. This it is believed will eliminate all disturbance of small gravel used to support the sand.

The accompanying illustration shows the component parts of this filter system to advantage. A comparatively thin gravel bed 3 in. thick, with particles $\frac{1}{2}$ to $\frac{5}{8}$ in. is used.

A New Road Builder's Truck of 1½-Yd. Capacity

Having a body capacity of 1½ cu.yd. and weighing 5,150 lb. complete, the new model 111-A truck, recently developed by the Indiana Truck Corp., Marion, Ind., has been designed especially for road-building service. The length available for loading space back of the seat is 6 ft. 2 in. long and the distance from the seat to the center of the rear axle is about 3 ft. 9 in. The truck has a turning radius of 24 ft. The body is of steel, with straight sides, and uses a hydraulic underbody hoist and a double-acting tail gate. The top of the body is 56 in. from the ground. In

dumping the body attains an angle of 60 deg.

The truck is equipped with a four-cylinder, 4-in. bore, 5 in. stroke engine and the car is equipped with closed cab and all other accessories.

Pump Improvements

The De Laval Steam Turbine Co. has furnished figures showing the improvements that have been made in steam turbine driven centrifugal pumps purchased from them by the City of Chicago since 1922. These are shown in the accompanying table. Incidentally, the De Laval company points out that its pumping units installed in the Chicago Avenue, Central Park, Springfield Avenue and Western Avenue pumping stations can deliver more than half of the capacity of the water works system of Chicago, which is placed at 1,300,000,000 gal. per day. During the past year the company has installed four 75 m.g.d. steam turbine driven centrifugal pumps each operating at 150 ft. head in the Western Avenue station, which is claimed to be the largest municipal water works pumping station in the world.

COMPARISON OF CHARACTERISTICS OF 60 MGD PUMPS INSTALLED IN CHICAGO AT 2 YEAR INTERVALS

Description	1922	1924	1926
Steam pressure, specifications, lb.	175	175	175
Steam pressure on test	168.04	142.1	176.15
Superheat specifications	150°	150°	150°
Superheat on test	126.6°	123.6°	133.4°
Capacity MGD specifications	60	60	60
Capacity MGD on test	60.0	59.0	60.66
Head specifications	150	150	150
Head on test	151.51	150.35	152.66
R.P.M. specifications	530	530	530
R.P.M. on test	507	501.5	507.4
Duty guarantee specifications	152	168	179.8
Duty actually obtained on official test	154.362	172.0	191.3

Parallel Rule Use Sprocket Wheels and Chain

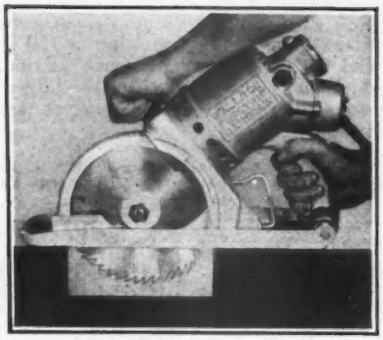
The important advantages claimed for the new parallel rule recently developed by C. F. Pease Co., Chicago, Ill., are that it eliminates much tire-

some drafting work when used in place of a T-square, it is always handy and has been so simplified that it seems a part of the drafting table.

This new parallel rule attachment is constructed entirely of metal, the complete mechanism being beneath the table. Four sprocket wheels connect the double chain drive and a revolving shaft between two of the wheels maintains uniform operation. In parallel position to each other on either side of the board, two special clamps are fastened to the chain. These clamps are designed to hold any standard straight edge. It is further said that the rule can be applied to any table in 15 min. and that it eliminates all troubles experienced with cord and pulley operated straight edges.

New Electric Handsaw

A new 8 in. electric handsaw designed to be operated similarly to a plane, and especially constructed for safety, has recently been announced by J. D. Wallace & Co., Chicago, Ill. Either a.c. or d.c. may be used and maximum efficiency is claimed to have been secured by con-



necting the motor direct to the saw spindle. The motor cannot be overloaded and in every way the saw is claimed to be fool-proof. A guard covers the blade at all points. When the operator wishes to cut, he simply releases the safety guard by means of a trigger conveniently placed near the grip. When the cut is finished the shoe automatically drops and locks in position covering the blade.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL HARDWOOD LUMBER ASSOCIATION, Chicago; Annual Convention, Chicago, Sept. 15-16.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; Semi-annual meeting, Aviation Country Club, Detroit, Sept. 19-21.

AMERICAN PAINT & VARNISH MANUFACTURERS ASSOCIATION, Philadelphia; Annual Convention, Atlantic City, Oct. 24-25.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York; Annual convention, Pinehurst, N. C., Oct. 25-29.

NATIONAL ASSOCIATION OF MANUFACTURERS; Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

New Publications

Crawlers for Trucks—U. S. WHEEL TRACK LAYER CORP., Rahway, N. J., has issued an 8-p. booklet describing its Christie crawler units for application to all makes of motor trucks. Illustrations and text show the manner of application, the former also showing many types of work upon which crawler treads have widened the application of motor truck service.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Building Decline Mainly in Offices, Warehouses, Lofts, Depots and Stations

Drop In Value of Lettings First Half This Year Compared With Last In Apartments, Hotels, Schools and Garages

THE amount of money represented by contracts awarded for large engineering construction projects, Jan. 1 to date, is greater than that for the same period in 1926, according to observations covering nationwide activities in this field, maintained by *E. N.-R.* Building materials cost less, while labor is higher than at this time last year.

With demand for materials not greatly in excess of that existing a year ago and a growing tendency toward accumulation of heavier reserve stocks, developing in the petroleum, automotive, steel, brick and lumber industries, it is not surprising to find a drop of 32½ per cent in industrial building contracts, compared with the first half of 1926.

Attention is accordingly drawn to the class embracing buildings other than industrial. In this group a definite drop occurred in value of lettings for apartments, hotels, schools, office buildings, warehouses, lofts, garages, depots and stations, comparing the figures for Jan. 1 to July 1, 1927 with those of the corresponding period last year.

Substantial gains, however, are noted in value of awards for new hospitals, stores, theaters, churches, lodges, halls, clubs, public buildings, banks, and exchanges.

While apartments gained heavily over hotels (124 per cent) the two together, declined in money value and increased in actual number of projects.

Office buildings declined in both number and value as did warehouses, lofts, depots and stations.

Garages gained in number and declined in value of lettings, while the opposite condition obtained in exchanges.

The increase of 5 per cent in total money value is accentuated by a gain of 17 per cent in actual number of projects.

CONTRACTS AWARDED IN U. S.—BUILDINGS OTHER THAN INDUSTRIAL—$150,000 VALUE AND OVER

Class	First Six Months 1927	First Six Months 1926	Per Cent Gain (+) or Loss (—) Compared With 1926
Apartments and hotels	$203,671,000	$212,316,000	—4
Schools	92,294,000	98,232,000	—6
Offices	92,449,000	170,936,000	—46
Hospitals	47,572,000	34,048,000	+41
Stores	44,550,000	18,553,000	+137
Warehouses and lofts	18,647,000	31,060,000	—39
Theaters	70,476,000	25,151,000	+180
Churches	39,075,000	30,903,000	+26
Lodges, halls and clubs	27,053,000	21,666,000	+23
Public buildings	24,901,000	17,372,000	+47
Garages	12,400,000	13,100,000	—8
Banks	54,208,000	11,228,000	+391
Exchanges	8,800,000	4,658,000	+80
Depots and stations	1,225,000	10,283,000	—90
Total	$737,321,000	$699,506,000	+5

NUMBER OF CONTRACTS AWARDED IN U. S.—BUILDINGS OTHER THAN INDUSTRIAL—$150,000 VALUE AND OVER

Class	First Six Months 1927	First Six Months 1926	Per Cent Gain (+) or Loss (—) Compared With 1926
Apartments and hotels	553	444	+25
Schools	325	316	+3
Offices	157	231	—32
Hospitals	121	67	+81
Stores	74	42	+76
Warehouses and lofts	46	60	—23
Theaters	110	65	+69
Churches	143	111	+29
Lodges, halls and clubs	85	70	+21
Public buildings	57	42	+36
Garages	46	43	+7
Banks	87	40	+118
Exchanges	13	15	—13
Depots and stations	4	5	—20
Total	1,821	1,551	+17

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total Contracts
July 21, 1927	$16,847,000	$23,895,000	$40,742,000
July 14, 1927	26,873,000	49,319,000	76,192,000
July 22, 1926	20,694,000	26,089,000	46,783,000
Jan. 1 to date			
1927	673,317,000	1,008,048,000	1,681,365,000
1926	614,198,000	995,771,000	1,609,969,000

E.N.-R. Index Numbers On July 1, 1927

COST	VOLUME
203.68	297

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 48-page pamphlet entitled Engineering News-Record Construction Costs.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.80	$4.00	$3.10	$3.35	$3.87½	$3.10	$3.00	$4.00
Structural rivets, 100 lb.	5.00	3.80	4.75	3.50	3.75	4.64	5.00	+5.25	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	2.80	2.75	2.30@2.50	2.87½	3.77½	2.95	3.00	3.57
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	54%	51%	48%	41%	42@53.8%	48%	37.83
Cast-iron pipe, 6 in. and over, ton	46.60	40.00	54.00	44.20	46.50	56.50	49.00	55.00	55.00
Concreting Material									
Cement, without bags, bbl.	2.35	2.40	2.05	2.05	2.22	2.85	2.51	2.65	2.22
Gravel, ¾ in., cu.yd.	1.75	2.20	2.38	2.00	1.65	1.90	1.80	1.25	1.90
Sand, cu.yd.	1.00	1.40	2.00	2.00	1.25	1.00	1.40	1.25	1.35
Crushed stone, ¾ in., cu.yd.	1.85	2.50	2.83	2.00	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	59@61	34.00	56.00	40.50	39.25	34.25	27.00	23.00	55.00
Lime, finishing, hydrated, ton	18.20	24.50	19.00	20.00	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl.	2.10@3.00	1.35	1.82	1.50	1.70	2.70	1.70	2.80	10.00
Common brick, delivered, 1,000	—17@18	12.50	13.60	12.00	13.75	9@10	14.00	14.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0724	.103	.076	.072	.085	....	.10	.10
Hollow partition tile, 4x12x12, per block	.1027	.0724	.103	.076	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	—.85½	+91½	1.10	.86	.96	—1.08	—.92	+.98	1.08
Common Labor									
Common labor, union, hour	.90⅝	.30	.....	.96	....	....	.60	+.70	....
Common labor, non-union, hour	....	.25	30@.50	....	45@.60	.31¼@.50	.50	.62½	.30@.35

THE steady downward price trend of building materials as a group, broken only by slight recoveries which occurred late in the autumn of last year and also in the spring of 1927, shows no indication of change from the direction taken at least ten months ago. Labor costs, particularly those in the skilled trades, have moved steadily upward during the same period in which materials prices declined. With one balancing the other, the difference in total cost has been insufficient to interfere with the continued high volume of demand as shown by contract values.

The market in building materials is not unlike that of most of the other wholesale commodities, so far as downward price trend is concerned. Steel and cement have shown the greatest resistance to price decline since September, 1926, with brick and lumber next.

Pig-iron prices have evidently reached the lowest levels of the year. Scrap, all descriptions, continues weak.

THIS limited price list is published weekly except in the first issue of each month and gives current prices on the principal construction materials in the chief cities. Valuable suggestions on costs of work can be had by noting actual biddings as reported in the Construction News and Unit Prices sections following.

The first issue of each month carries complete quotations for all of the basic materials and for the rest of the important cities, also wage rates for the principal building trades and common labor. The last complete list will be found in the issue of July 7, the next on Aug. 4. Explanation of prices contained in the table will appear from time to time in this section; last shown June 16, 1927, p. 1006.

Reinforcing bars are $1.80@$1.90 per 100 lb., f.o.b. Pittsburgh mill, with shapes and plates, base sizes, $1.75@$1.85. The higher quotation in each case applies on lots of from one to six carloads. Cast-iron pipe is following prices of pig-iron and scrap downward.

Figures covering unfilled orders on books of the United States Steel Corporation, as of June 30, 1927, show the first gain since December, 1926. The increase, which amounted to less than one per cent, was a highly favorable though unexpected development.

Cement prices have been steady since the break in the market which occurred at Boston about a month ago. This decline was undoubtedly due to temporarily heavy imports. Cement mill shipments are at peak levels.

Common brick dropped $1 per M at New York during the week, owing to surplus induced by quantities of used brick which were thrown on the market, following extensive demolition operations. Yards in the Hudson River district, particularly those in the vicinity of Beacon, N. Y., are closing down, due to slowness of buying; meanwhile foreign brick receipts appear in smaller volume. Yard stocks of burned brick for the nation as a whole are over 31 per cent above those on hand a year ago.

Fifty Biggest Contracts Let During First Twenty-Four Weeks of 1927 Total $285,000,000

Cover Practically Every Type of Heavy Engineering Construction—Average Value $5,691,000

THE maximum amount of money expended on a single construction project, anywhere throughout the country during the first twenty-four weeks of 1927, was $22,282,309, the value of the New York subway job, Section 1, Route 101, awarded to the Mason & Hanger Co., of this city.

Altogether, the fifty largest projects awarded during the period in question, totaled nearly $285,000,000, with an average contract value of $5,690,715.

The six largest jobs comprised, in addition to the project just mentioned, the Saluda River (S. C.) hydro-electric power plant, $20,000,000; a gas pipe line, from the Panhandle district of Texas to Kansas City, Mo., $20,000,000; the Detroit-Windsor bridge, $20,000,000; Section 3, Route 104, of the New York subway system, $10,481,550; extension of the L. Bamberger & Co. department Store, Newark, N. J., $10,000,000.

It is natural to expect that the bulk of the money expenditures involved in these projects would be divided between the Chicago and the New York districts. The former accounted for $49,931,949 or 18 per cent, while the latter spent $64,610,144 or 23 per cent of the total for the fifty projects. The remaining contracts were sufficiently scattered to cause a fairly heavy demand for construction materials and labor in the less densely populated sections of the country. These fifty jobs cover almost every classification.

WHERE JOBS ARE LOCATED

FIFTY LARGEST CONTRACTS AWARDED IN THE U. S. DURING FIRST TWENTY-FOUR WEEKS OF 1927

	Nature of Job	Location	Contract Let By	Contractor	Amount
1.	Theatre and office building	New York, N. Y.	Roxy Theatre Corp.	Channin Constr. Co., New York, N.Y.	$5,000,000
2.	Apartments	Chicago, Ill.	Syndicate	Reliance Co., Inc., Chicago, Ill.	5,250,000
3.	Jail, court, etc.	Chicago, Ill.	Supt. Pub. Service	Great Lakes Constr. Co., Chicago, Ill., and others	7,015,949
4.	Mercantile building	Los Angeles, Calif.	Sears, Roebuck & Co.	Scofield Eng. Constr. Co., Los Angeles, Calif.	5,000,000
5.	Grading, culverts, bridges	Missouri	Missouri Pacific R.R. Co.	Winston Bros. Co., St. Louis, Mo.	3,000,000
6.	Theatre and office building	St. Louis, Mo.	William Fox Film Co.	Aronberg & Fried, Inc., New York, N. Y.	3,250,000
7.	Hydro-electric development	Oregon	California-Oregon Power Co.	Byllesby Eng. & Management Corp., Chicago, Ill.	3,250,000
8.	Highway	New Jersey	State Hy. Comm.	Montrose Constr. Co., New York, N. Y.	3,244,951
9.	Bank and office building	Philadelphia, Pa.	Fidelity-Philadelphia Trust Co.	Irwin & Leighton, Philadelphia, Pa.	7,448,000
10.	Theatre and office building	Detroit, Mich.	Detroit Properties Co.	Walbridge-Alldinger Co., Detroit, Mich.	6,000,000
11.	Bridge	Over Hackensack River, Jersey City, N. J.	D., L. & W. R.R. Co.	H. F. Curtis; American Bridge Co.; Foundation Co., New York, N. Y.	3,000,000
12.	Department store	Newark, N. J.	L. Bamberger & Co.	G. A. Fuller Co., New York, N. Y.	10,000,000
13.	Bank and office building	Chicago, Ill.	City State Bank	Dilks Constr. Co., Chicago, Ill.	2,500,000
14.	Hotel	Milwaukee, Wis.	Schroeder Hotel Co.	W. W. Oeflein Inc., Milwaukee, Wis.	3,000,000
15.	Office building	Tulsa, Okla.	Waite Phillips Oil Co.	Long Constr. Co., Kansas City, Mo.	2,500,000
16.	Office building	Albany, N. Y.	State Office Site and Bldg. Comm.	Seglin Constr. Corp., Buffalo, N. Y.	2,538,198
17.	Store	Memphis, Tenn.	Sears, Roebuck & Co.	B.-W. Constr. Co., Chicago, Ill.	2,500,000
18.	Theatre, store, etc.	Chicago, Ill.	A. Karzas	Longaere Constr. Co., Chicago, Ill.	5,000,000
19.	Apartment	Chicago, Ill.	W. C. Bannerman & Co.	H. Janisch & Co., Chicago, Ill.	3,500,000
20.	Freight terminal	Youngstown, O.	Erie R.R. Co.	C. Shutrump & Sons Co., Youngstown, O.	6,750,000
21.	Bank and office building	New York, N. Y.	National City Bank	G. A. Fuller & Co., New York, N. Y.	8,000,000
22.	Hydro-electric power plant	Saluda River, near Columbia, S. C.	Lexington Water Power Co.	W. S. Barstow Management Assn., Inc., New York, N. Y.	20,000,000
23.	Subway	New York, N. Y., Sect. 3, R 104	Board of Transportation	Patrick McGovern, Inc., New York, N. Y.	10,481,550
24.	Apartment	Upper Darby, Pa.	H. R. Weldon, archt.	Smith-Hardican Co., Philadelphia, Pa.	2,500,000
25.	Exchange	Denver, Colo.	Mountain State Tel. & Tel. Co.	C. E. Walker Constr. Co., Denver, Colo.	2,500,000
26.	Factory	Cambridge, Mass.	Kendall Industrial Building Trust	S. C. Sperry Co., Cambridge, Mass.	3,000,000
27.	Subway	New York, N. Y., Sects. 1 & 2, R. 104	Board of Transportation	Patrick McGovern Co., New York, N. Y.	9,700,195
28.	Church, hotel, etc.	Minneapolis, Minn.	Wesley Methodist Church	Wells Bros. Constr. Co., Chicago, Ill.	5,000,000
29.	Gas pipe line	Panhandle, Tex. to Kansas City, Mo.	Texas Corp. & Columbian Carbon Co.	Hope Eng. & Supply Co., Mt. Vernon, O.	20,000,000
30.	Bank and office building	Chicago, Ill.	City State Bank	Languist Constr. Co., Chicago, Ill.	5,000,000
31.	Exchange and office building	Chicago, Ill.	Chicago Mercantile Exchange	Paschen Bros., Chicago, Ill.	3,500,000
32.	Theatre	Chicago, Ill.	South Center Amusement & Business Enterprise	J. Sheldon Co. and others, Chicago, Ill.	2,500,000
33.	Stadium	Chicago, Ill.	P. J. Harmon	J. W. Snyder Co., Chicago, Ill.	2,666,000
34.	Dredging	Fort Lauderdale, Fla. / Bay Marble Harbor, Fla.	City Comm. / City Comm.	Tropical Dredging & Constr. Co., Hollywood, Fla.	2,571,217
35.	Highway	New York	State Comm. Highways	Stapell, Mumm & Beals Corp., Gardenville, N. Y. and others	2,432,978
36.	Hotel and restaurant	Atlantic City, N. J.	Childs Co.	G. A. Fuller, New York, N. Y.	3,574,090
37.	High school	New York, N. Y.	Board of Education	Gibbs Rice Co., Inc., New York, N. Y.	2,500,000
38.	Sewage disposal plant	Philadelphia, Pa.	Dept. Pub. Works	Mason & Hanger Co., New York, N. Y.	2,572,000
39.	Apartment	Chicago, Ill.	Leander McCormick Estate	Lundorff-Bicknell Co., Chicago, Ill.	3,301,311
40.	Mills	Gary, Ind.	American Sheet & Tin Plate Co.	Great Lakes Constr. Co., Chicago, Ill.	4,000,000
41.	Bridge	Over Mississippi, between Cairo, Ill. and Birds Pt., Mo.	Cairo Bridge & Terminal Co.	Substructure—Missouri Valley Bridge Co., Leavensworth, Kans. Superstructure—American Bridge Co., New York, N. Y.	6,000,000
42.	Bank and office building	New York, N. Y.	Central Savings Bank	Hegeman, Harris Co., Inc., New York, N. Y.	3,100,000
43.	Office building	Dallas, Tex.	Southwestern Bell Tel. Co.	Virginia Bridge & Iron Co., Dallas, Tex.	3,000,000
44.	Bridge	Mid-Hudson, Poughkeepsie, N. Y.	Supt. of Pub. Works	American Bridge Co., New York, N.Y.	2,300,000
45.	Hospital	Orangeburg, N. Y.	Dept. Mental Hygiene	Niewenhous Co., Inc., New York, N. Y.	2,963,000
46.	Store and office building	Chicago, Ill.	Insurance Exchange Bldg. Corp.	American Bridge Co., Chicago, Ill.	5,153,776
47.	Bridge	Over Detroit River, Detroit, Mich. to Windsor, Ont.		McClintic-Marshall Co., Pittsburgh, Pa.	5,000,000
48.	Highway	New York	State Comr. Highways	A. C. Bailey, Phillipsburg, Pa. and others	20,000,000
49.	Office and store	Chicago, Ill.	Coffey & McKeown	Dilks Constr. Co., Chicago, Ill.	4,990,215
50.	Subway	New York, N. Y., Sect. 1, R 101	Board of Transportation	Mason & Hanger Co., New York, N. Y.	4,000,000
					22,282,309
				Total	$284,535,739